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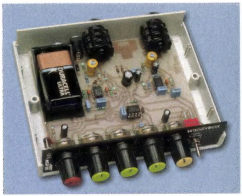

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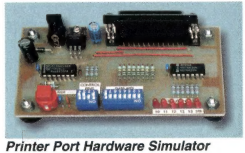

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PUBLISHER'S LETTER

We use too many batteries

How many battery-operated gizmos do you have in your household? Ten, twenty, thirty or more? Not even 10, you say. Well think again. You may easily find that you have more than 50. If you have children with battery-operated toys, you might have a lot more.

If you answered "less than 10" to the above question, you may have just been thinking of battery-operated tools such as a portable drill or an electric toothbrush but a little thought quickly rounds up many more and the list grows inexorably.

Just step into your car for example. You probably have a keyless remote and a control for your garage door. Got two cars? That's four battery-operated gizmos already.

Now you're in the family room and there are infrared remotes for your TV, VCR, DVD player, CD player, home theatre receiver, etc. That's at least another five and then there are the memory backup batteries in the TV and VCR, plus the quartz clock on the wall. And you probably have other quartz clocks and at least half a dozen quartz watches between you and your partner, so we're already up to 20 or so battery devices.

Smoke detectors, anyone? Cordless telephone? Mobile (cell) phone? Toothbrush, Shaver, Torches? Count a battery for each plus at least one battery in the burglar alarm. That's probably another 10, making around 30 so far.

Step into your office. Your computer has a backup battery. And you probably have another entertainment system or TV with remote controls for both. There's probably an LCD clock on your desk. How about a transistor radio? There are probably a few of those spread around the house. Your battery device count is probably at least 35 by now.

OK, step into your son's or daughter's rooms. Hell, it's battery city in there (if you can see any clear space)! There are the remotes for their entertainment systems, TV, games console, Discman player (these eat batteries!), ghetto blaster, mobile phone (again), watches (these are fashion accessories – they need at least five!) and LED jewellery. If you have two teenage children, the battery device count is probably already over 50 and there is still your workshop. Battery-powered tools? Yep, there's a few of those too.

And what about big boys' (and girls') toys? Cameras, camcorders? Radio-controlled cars, boats, planes? Computer-controlled telescope? (OK - that's a rare one!) You see what I mean? By now, if you have a normal household you probably have a count approaching or exceeding 70 or more battery-operated devices in your household. All told, if you took all these batteries out and lined them up, you could easily have well over a hundred batteries.

Well, now you can see that this is getting to be a really big problem. Not only do they cost a heap to replace but when you throw them away, they present a disposal problem. No wonder mercury is no longer a component of most batteries - just as well.

What can you do about it? Not a great deal, but next time you are considering purchasing a new appliance, does it really need a battery-operated remote gizmo? And can you eliminate some of your remotes by just using a universal remote in the family room? Maybe your next watch (do you really need another watch anyway?) can be a non-battery type; they still make them.

Naturally, if you can run a battery-operated device from a plugpack, you should do so. That is why we try and make all our published battery-operated circuits able to run from a plugpack, if at all possible. Of course, if you can use rechargeables, you should do so, although they are not practical in many applications.

Finally, a tip: you can recycle some batteries. After your children have "used up" the batteries in their Discmans, etc, they can still be used to power low-current devices like clocks, some remotes and so on.

Leo Simpson

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Warning about camera flash capacitors

I have a warning for readers wanting to experiment with the Neon Scintillator described in "Circuit Notebook" in the April 2003 issue.

Several years ago, I was scavenging parts from a camera flash unit. The reason for doing this has been forgotten but the consequences will never be. Seeing the 300V capacitor in the unit, I correctly decided that it should be discharged before proceeding. Shorting the cap's terminals (as suggested in the Neon Scintillator article) with the tips of a pair of side-cutters seemed like a good idea at the time.

The bang that followed was like a gun going off next to my ear and the arcing was intense enough to mangle the tips of my nice side-cutters and blow the solder on the board to who knows where.

A little imagination will conjure up more serious consequences than ringing ears and ruined tools, so take care and use something more resistive than side-cutters when discharging these "traps for the unwary".

Adrian Righetti,
via email.

Comment: we take your point. However, it does seem as though the discharge you obtained was rather more dramatic than we would have expected from a smallish capacitor, even though it might have been charged to the full 300V.

AETA formed to fight Queensland electrical legislation

As indicated in your Publisher's Letter in the March 2003 issue, the All Electronic Technicians Association Incorporated has been formed and registered in Queensland under the Associations Incorporation Act 1981 and our registration number is IA31906.

Our sole aim is to oppose the current implementation of the Electrical Safety Act 2002 (Queensland). This act has the potential to ruin many electronic repair businesses as it currently exists and goodness knows how it may evolve if left unchallenged. It most likely would spread to other states if we do not keep a close watch.

We intend to attack the law at its roots by directly targeting the politicians who passed it and demanding changes to allow electronic repairers to continue their work without the onerous imposts of this law. The average small business will need to spend more than $1000 per year to comply with this law, not to mention the time spent filling out forms and that's if they are lucky enough to actually be in a position to comply. Penalties for not having this licence include up to six months jail!

AETA has a document from the Electrical Safety Office that says that currently a licence is not required if 100% of your work is done within a workshop but this part of the law refers to manufacturing workshops. AETA believes that it will not be long before this loophole is plugged, requiring all repair workshops to have a licence (if you can qualify for one).

The committee is well aware of the campaign SILICON CHIP ran a few years back that met with complete apathy. That is the main reason we are now left fighting after the event. It is important for the survival of every electronic business that we succeed in our efforts and to do that we need numbers. Without a strong membership base politicians will not listen to us.

This might be the last chance we all have to put a stop to this outrageous law. Let's not lose it. I urge everyone involved in any form of electronics to contact us for more detailed information at **cairnscomms@iprimus.com.au**

Mike Kalinowski,
President AETA.

Eprom programmer protection resistors

I was pleased to see that at least some form of input protection has applied to the Eprom Programmer featured in the November & December 2002 and February 2003. With regard to the unit being in program mode when not connected to a PC, I would recommend that constructors replace at least one of the address "pull-up" resistors with a "pull down" resistor of 47kΩ. This will select a safer function when the unit is not connected to a PC. There is nothing magic about "pull-ups" when dealing with high impedance circuits like HCMOS. Pull-downs provide an equally valid defined state.

The series input resistors really should have a much higher value than 100Ω and the "pull-ups" should be on the connector side, not the IC side where they cause a voltage drop across the series input resistors.

Graham Lill,
via email.

Comment from Jim Rowe: the points you make are entirely valid. If it had been easier to change the PC board pattern to incorporate the changes you suggest neatly, I would have done so.

Reproducing old wireless sound

I saw the request from R. W. in "Ask Silicon Chip" (March 2003) about his staging of a play and wanting to have music sounding as though coming from an early radio. This may not solve all his problems but I use Cool Edit Pro, which came on the free CD ROMs attached to the August 2002 issue of PC User magazine. This software has mono, stereo and multi-track recording functions and I use it for transferring vinyl LPs to CD.

Among the various tools are several filters and numerous effects, including one called "Old Time Radio", which gives the audio a "thin, strained & tinny" sound, very similar to a "small-speakered" radio. The software can't add hiss and crackle of course; it's designed to remove them, but using the graphic and parametric equal-

isers, as well as the DTMF filters and other tools, R. W. may be able to distort the sound to the point where it sounds pretty close to what he wants. Adding some white noise or the recorded sound of chips frying in hot oil (not kidding!) might do the trick.

Peter Cahill,
via email.

Comment: actually, old time radios did not have a "thin, strained and tinny sound". Depending on the radio's cabinet, the sound was generally more "mellow" (ie, lacking high frequencies) and often quite bassy. Some of the larger console radios with 12-inch speakers and push-pull output stages sounded very good.

"Thin, strained and tinny sound" really only came about with the introduction of tiny transistor portable radios, often poorly designed to cope with the failing voltage from tiny batteries.

Loves LED stop lamps

I have just completed my own (stop & tail) version of the LED tail light featured in the March 2003 issue. I used 6500mCd 5mm LEDS from Jaycar as they are only 44 cents each, in lots of 100. And after what I saw last night I've now got five cars to do (three old stop/tails and two new centre mount stop only conversions)! In a word – WOW!

For stop/tails, I have four LEDs lit for the parking lamp, while all 12 light for stop (or the other eight if the parkers are on). I fitted one of these to my old '68 Valiant and did the comparison between the normal stop/tail globe and the LED version. The old girl had pretty abysmal tail lights from day one but now with the LED version you can plainly see the difference.

The parkers are brighter, on par with newer vehicles and the stop, well, that's awesome. As the "C" section shape of the lens assembly does not allow for side viewing (as with newer vehicles), this is not a problem. The LED assembly has to be mounted lower in respect to the bayonet housing to get an acceptable scatter of light in the reflector but this is no problem as a shorter spacer is used.

Similarly, in my '68 Dodge Phoenix, with four stop/tails on the rear, I will replace the inner lamps with LED assemblies as these don't have a chrome "filler" piece across the centre of the lamps as the outer ones do. The outer lamps need to stay standard as this filler piece doesn't work well with the LEDs and the cruise control uses a normal lamp to sense whether the brakes have been applied.

During my test, it was plainly obvious how slow normal lamps are to light. You are correct. You can actually see the time lag between normal lamps and LED modules if you look at the normal lamp with the LED module in your peripheral vision. I wouldn't have believed it if I hadn't seen it for myself.

All in all an excellent project.

Brad Sheargold,
via email.

Comment: thanks for the wrap-up. We will have more to say about stop/tail LED versions in a future issue.

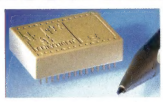
Enthusiasm for PICAXE series

After buying the February 2003 issue on spec I got enthusiastic and ordered a couple of PICAXE-08s. They conveniently came just before a wet Melbourne weekend. I got out the protoboard and chopped the tail off an old mouse, etc.

Of course with RS-232 involved my bet was it wasn't going to work first off. The closest I came was on one of three systems which actually downloaded but gave an EEPROM verification error. I even went and got an RS232 converter MAX232 and that did not work. I then carted the system off to work and tried on my office PC, using short hook-up wire from the port - no go at all! And I know the ports on this machine reliably connect to RS232-equipped balances and voltmeters.

After discussion with my work colleague, he made the suggestion of fitting a large low impedance non-electrolytic filter capacitor close to the PICAXE. That did the trick; presumably the internal 4MHz oscillator is feeding enough interference out to cause a problem. I had used the demo program on page 13 and was wondering why the LED was not on. I grabbed the voltmeter and was about to measure when I noticed the power supply had sunk to 2.8V (from 5V). I stupidly

The Tiger comes to Australia



The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

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started to wind up the voltage and it went into current limit at whatever I had last set it. A quick finger test as I switched off confirmed a very hot PICAXE.

It appeared that some combination of conditions had caused an internal latch up. The PICAXE survived; glad I didn't get it working at home with a 5V supply with no current limit. I modified the program to give a 1-second duty cycle and no problem; I haven't tried a faster cycle yet.

It appears from looking at the Rev_ed forum that the 08 is rather sensitive to the supply voltage. Using 4 x 1.5V batteries did not work for somebody and the "tech support" reply was to use three, thus 4.5V. That does not work programming my PICAXE.

So as usual anything new takes three times as long as it should and nobody has the time these days. A nicely presented article with all the facts and references one needed. Keep up the good work.

Roger Curtain,
Department of Chemical & Biomolecular Engineering,
University of Melbourne.

Computer service in Qld

Are you aware that the new Queensland Electrical Safety Act 2002 not only applies to appliance repairers but also persons doing COMPUTER SERVICE work? Under the new Act anybody doing service to anything that connects to the 240VAC mains now need to have a current Electrical Work licence *and* an Electrical Contractor's Licence. This applies to service to everything from a coffee dispenser to a PC.

The relevant sections of the Act are 55, 56, 18 and 14. Section 27 describes the maximum penalty of $35,000 or 6 months JAIL for individuals or $180,000 for corporations. Check out **www.eso.qld.gov.au** for more information.

The general public probably don't care two-hoots about the state of TV service in Queensland. But with the incredible saturation of PCs in the home, schools and workplace one would think that this would rouse some interest.

As well, computer service people themselves probably think that none of this applies to them when it certainly does. In my area, there are only a handful of TV service people but hundreds of computer people!

This ridiculous legislation can only be overturned with lots of popular support.

David Dorling,
Buderim, Qld.

Comment: this topic has been well-canvassed in recent issues. But you are right; computer service is more important to the general public. In the meantime, perhaps you should ensure that all the computer technicians you know join the AETA in Queensland.

CD anti-copy: shooting the foot?

Invariably, copyright publicity like CD piracy is generated by companies wanting to sell their solutions. Most times, these 'solutions' hit loyal customers harder than the criminals. For example, when they introduced copyright protection on videotapes (Macrovision), I had to scrap a $900 enhancer and rewire my video system. Prior to then, it made viewing considerably clearer with less noise and correct colour.

Did this stop the pirates? No! I watched less videos, though.

Now CDs made with copyright protection do not track on all players and CD purchasers cannot make a copy of their CD for replay in their car. Copying has long been better than using your original, as car thieves invariably steal CDs and cash, plus the original is easily scratched in the car.

By their own admission, music suppliers really are aiming to combat illegal net sites. These sites will remain, as they have various sources (especially Asia) and electronic restorers. The only losers, the public, will have an inferior product.

The music companies know that mainstream piracy is on the decline. Their reduced sales are due to the quality of the product and competition. New CDs are over $20, the same cost as a host of movie DVDs. More people are watching movies.

The music companies are shooting themselves in the foot, as many customers like me, will stock older CDs and ignore new releases with "protection". This is not difficult, as new music has less attraction in recent years.

I feel just as passionate about computer software. Microsoft sells the Office suite for over $900, then doesn't allow even the original owner to have a copy on his PC and laptop. There is a competitor, "Thinkfree Office", that sells for $99 and allows copies to be used on any of your computers!

Music companies should fight the Internet pirates instead of disadvantaging their customers. It's not as hard as it seems. Sites are traceable and filters are available to stop reception.

Kevin Poulter,
Dingley, Vic.

LED vehicle lighting article

I just read Jim McCloy's email in the April issue rubbishing your March 2003 article on vehicle LED lighting and I wanted to offer my support for your magazine's stance and response.

I agree with your puzzlement over his comments about the front driver bearing responsibility for safe driving distances; if all drivers were to follow this practice, then surely we would all be driving at unsafe speeds trying to escape the drivers behind us!

He says he's never been hit in the rear but how much risk is he placing the resting of us in by using his recommended driving technique? What happens when he reaches the speed limit?

Mr McCloy also appears to have overlooked the fact that car and truck manufacturers have been using LEDs in brake light systems for years now, and that companies such as Hella (**http://www.hella.com.au/**) manufacture the same types of aftermarket automotive lighting units as described in your article.

Perhaps he would like to take them to task for being 'irresponsible' as well?

Please keep up the great work on my favourite magazine!

Paul Sun,
Crows Nest, NSW. SC

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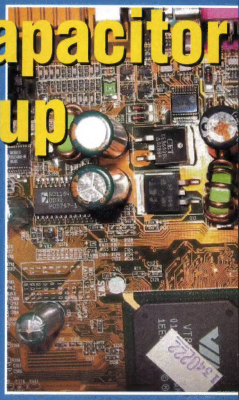
Motherboard capacitor problem blows up



There have been a number of reports in newsgroups and on-line services about leaky electrolytic capacitors on computer motherboards. Here are the facts and what to do about it if your PC has this nasty problem.

By PETER SMITH

EARLY IN 2002, stories began appearing in on-line news services and news groups about the high failure rates of electrolytic capacitors used on PC motherboards. Technicians were reporting that the capacitors were rupturing, leaking and even exploding like never before.

Initially, there were only two clues to the mystery. First, the failing capacitors were more often that not to be found in the power supply section of motherboards. The capacitors used in this area are characterised by their need to have very low ESR (Equivalent Series Resistance– see panel).

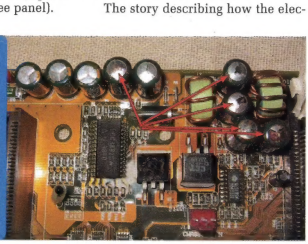
Second, most of the failing capacitors were identified as Taiwanese in origin. That's not too surprising at first glance, as Taiwan manufactures about 30% of the world's aluminium electrolytics (22.5 billion a year).

In September, "Passive Industry Components Magazine" published a story that exposed the reasons behind the unusually high failure rates. They reported that the failures were directly related to the use of faulty electrolytes in the manufacturing process.

Industrial espionage?

The story describing how the electrolytes came to be faulty reads like a lot of fiction. It begins in Japan, at a major capacitor manufacturer. A materials scientist for the Japanese company resigned and went to work for a Chinese capacitor manufacturer. While there, he reproduced one of the electrolytes used in his former employer's premium (low-ESR) aluminium electrolytic products.

Staff working with the scientist then defected, taking the secret electrolyte formula with them. They used the formula to manufacture their own electrolyte, which they subsequently flogged to major Taiwanese capacitor manufacturers at bargain prices. Unfortunately, their reproduction of the formula was flawed and the rest is history.



This motherboard stopped working and was returned to the workshop for repair. It wouldn't have taken the techos long to identify the problem. Check the bulging tops on these suckers! On some boards, up to a dozen capacitors have to be replaced.

A bad case of the squirts

So how does the faulty electrolyte cause early failure? Here we can only speculate. Some stories have stated that the flawed formula causes electrolysis, which in turn generates lots of hydrogen. Eventually, gas pressure ruptures the can or breaches the rubber end seal. We are inclined to think that since the electrolyte is used in

LEFT: the capacitors in the middle of the photograph are not a pretty sight, especially if found on your motherboard! Notice the bulging tops and the discoloration due to the leaking electrolyte. (Photo courtesy Carey Holzman – www.careyholzman.com).

low-ESR capacitors, the typically high ripple currents and resulting heat causes decomposition of the electrolyte. Either way, the result is the same – the capacitor eventually leaks or ruptures.

Apart from eventual self-destruction, leakage from these capacitors can also damage nearby components and circuit board copper, as the electrolyte compounds are quite corrosive.

Symptoms

When these capacitors fail, the signs are generally quite obvious. The top of the case may be split open or "bulged" upward and/or the can may be dislodged from its base (the rubber seal). There may also be an unpleasant smell and signs of electrolyte leakage nearby.

Even more obvious is the muffled explosion followed by the blank screen. Thankfully, we've heard that this failure mode is quite rare!

However, before catastrophic failure eventuates, all kinds of annoying symptoms can occur. These can range from intermittent boot failures to lockups in Windows. Eventually, the affected PC will refuse to boot at all, perhaps even before the culprits have showed themselves!

Brands affected

Unfortunately, there is no certain way of determining whether a particular motherboard is affected by this problem or not – until it fails. However, some of the big name manufacturers have identified their high-risk machines and have notified their customers accordingly.

What to do

If you've purchased a PC during the last 18 months or so, especially if it's not one of the big name brands, then it's worthwhile doing a quick check for any visible signs of the capacitor problem.

We should point out here that any number of other hardware or software problems can cause the symptoms mentioned above. Just because you PC has problem "X" does not mean that it is caused by faulty motherboard capacitors!

The capacitors to look for will be the largest (highest capacitance) types on the motherboard. Generally, they'll be situated somewhere near the power supply connectors. Also, you'll probably notice one or two toroidal inductors in close proximity. As designs vary so much between manufacturers and models, it's impossible for us to be more specific.

Unless you're experienced with such things, we don't recommend that you disassemble your PC. You'll probably be able to get a pretty good idea whether any of the larger capacitors are swollen or leaking with the board in-situ. A bright flashlight will help you here.

It's important to note that these capacitors are failing within a short period of use. This means that even if you're unlucky enough to be affected, it should be covered under your system's warranty!

What warranty?

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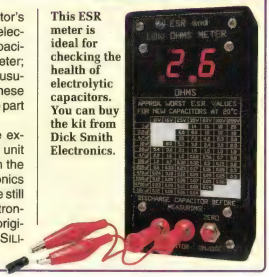
"Normal" Electrolytic Capacitor Failure

All electrolytic capacitors have a finite life, measured in thousands of hours. Unlike the exceptional cases discussed in this article, there are usually no external signs that a capacitor is nearing its end of life. However, it is possible to determine whether a capacitor is serviceable or not by measuring it's ESR (Equivalent Series Resistance).

ESR is the sum of in-phase AC resistance, including the resistance of the dielectric, plates, electrolytic material and leads at a particular frequency. As the name implies, ESR acts just like a resistor in series with the capacitance.

Towards end of life, a capacitor's ESR begins to increase as its dielectric losses increase. To test a capacitor's ESR, you need an ESR meter; an ordinary capacitance meter usually won't indicate a problem. These instruments are an indispensable part of any technicians toolbox.

Commercial ESR meters are expensive. However, an excellent unit was described by Bob Parker in the January 1996 edition of "Electronics Australia". Kits for this project are still available from Dick Smith Electronics and of course reprints of the original article can be obtained from SILICON CHIP.



This ESR meter is ideal for checking the health of electrolytic capacitors. You can buy the kit from Dick Smith Electronics.

warranty and you've determined that it has faulty capacitors. What do you do?

First up, you'll need access to the appropriate desoldering equipment in order to extract the offending parts without damaging your motherboard. Just as importantly, you'll need to identify and source suitable replacements.

As mentioned earlier, these capacitors are of a specific type; they have very low ESR. To understand the need for this requirement, let's take a brief look at the circuitry involved.

Low-ESR capacitors

Probably due to the fact that CPU core voltages change so often, designers have been forced to implement sections of the power supply circuitry on the motherboard. The standard power supply box still provides the usual 12V, 5V and 3.3V rails, but the lower voltages for the CPU core are provided by further step-down circuitry on the motherboard.

This on-board switchmode step-down circuitry runs at high frequencies (over 100kHz) to minimise the required inductance and filter capacitance. A key ingredient in this recipe is physically small electrolytic capacitors that can handle high ripple currents at high frequencies. In short, they must have very low impedance at the switching frequency.

As you can probably imagine, capacitors designed for use in mains filtering applications are not up to the job at all. They are physically much larger for the same capacitance and have high characteristic impedance at high frequencies. This would result in unacceptable amounts of ripple voltage and self-heating, leading to early failure.

The "Rubycon" (Japanese) brand ZL and ZA series ultra-low impedance capacitors will be suitable in most cases. They're available locally from Farnell Electronic Components – see Farnell's web site at **www.farnell.com** for more information.

Caution: the standard ZL and ZA series may be marginally larger in diameter than the original parts (10mm versus 8mm).

Other equipment

Any electronics equipment that incorporates high-frequency switchmode circuitry could be affected by this problem, including power supplies, monitors and games consoles, to name a few.

Only time will tell! **SC**

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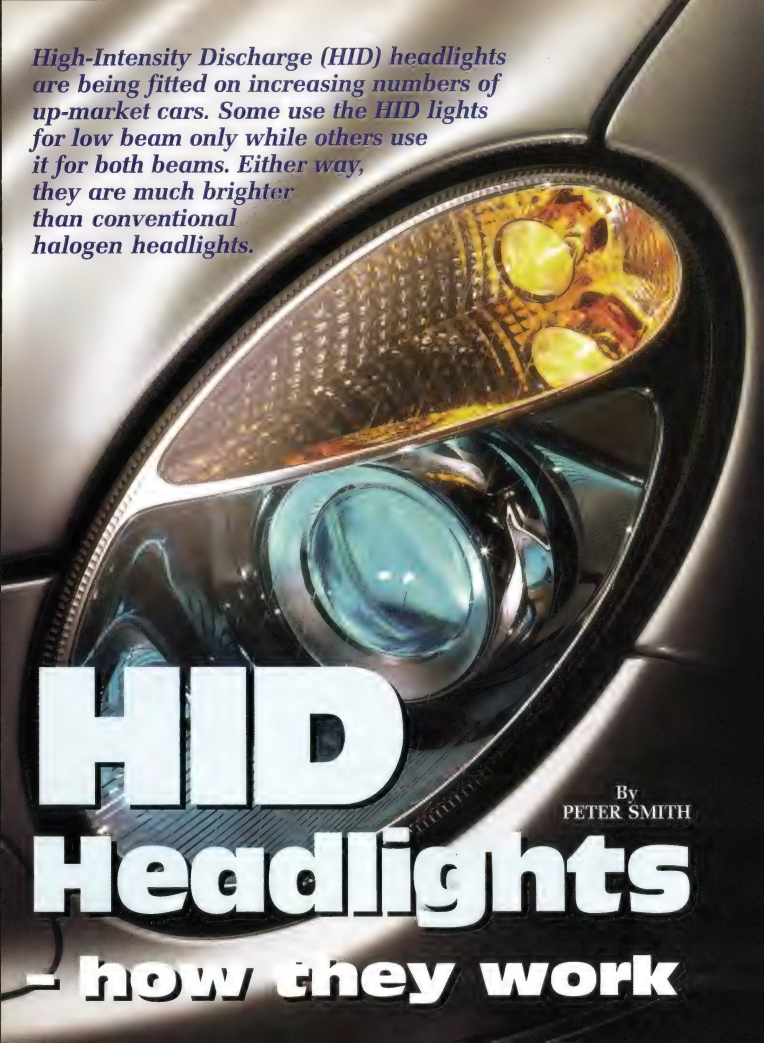
High-Intensity Discharge (HID) headlights are being fitted on increasing numbers of up-market cars. Some use the HID lights for low beam only while others use it for both beams. Either way, they are much brighter than conventional halogen headlights.



HID Headlights – how they work

By PETER SMITH

Even if you haven't heard of these new headlights, you've probably noticed the occasional piercing "bluish" flash on the road at night. HID headlights are already being fitted to up-market European, Japanese and American cars.

As you might have guessed, the technology used in these headlights is radically different from conventional tungsten-halogen headlamps.

Not only are HID headlights much brighter, they are much more efficient and draw less current from the battery.

History in a flash

All high-intensity gas discharge lighting is related to the original mercury vapour arc lamp, invented back in 1901 by an electrical engineer named Peter Cooper Hewitt.

The original mercury lamps were not very efficient (about 10%) and produced a rather harsh blue-green light.

The next major advances came with the inventions of the low-pressure and high-pressure sodium lamps. To this day, low-pressure sodium lamps are the most efficient commercially available lighting source.

However, they generate a pure monochromatic yellow light that is unsuitable for many applications.

The high-pressure version retains much of the efficiency (about 50%) and produces a "warmer" light colour, making it an obvious replacement for mercury lamps in street and factory lighting, where it is used extensively today.

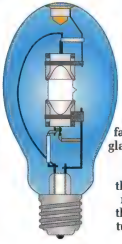
In a further search for efficiency and whiter light output, the General Electric company experimented with various iodine salts (indium, scandium, sodium, and thallium) in their mercury vapour lamps.

The result, born in 1962, was dubbed the "Multi Vapour Metal Halide" lamp, after the fact that iodine is one of the halogen elements.

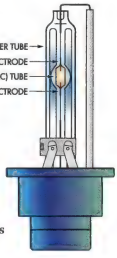
Derivatives of the first metal halide lamp can be found wherever an efficient, high-intensity white light source is required.

Uses for this type of lamp have until recently been restricted to industrial, high-wattage sizes in the 175W to 1500W range. Now, with a few modifications to lamp chemistry and some electronic circuitry, engineers have been able to adapt them to small, low power applications such as automobile headlights.

To understand the need for elec-



A current GE Multi Vapour Metal Halide lamp. The arc tube is suspended inside a familiar bulb-shaped glass enclosure. Overall height is almost 300mm. Notice the third (starting) electrode emerging from the bottom of the arc tube to the left of the main electrode.



Sketch of a Philips D2S HID lamp. The arc tube is tiny in comparison to a conventional MH lamp. This lamp is only 76mm high.

tronics, let's look first at the operation of a conventional metal halide lamp.

Metal halide lamp operation

A basic lamp consists of two "glass" tubes, one within the other. The inner tube is made from fused quartz or ceramic and houses two main electrodes and a starting electrode.

The tube is filled with an inert gas (argon) which has been "spiked" with a tiny quantity of mercury and various halide salts.

The outer glass envelope serves a number of purposes. It isolates the hot inner tube (up to 800°C) from the outside world. It also filters out some of the shortwave UV radiation, which if left unchecked is a health hazard and can damage rubber and plastic components.

When power is applied, the voltage between the starter electrode and nearby main electrode causes ionisation of the argon gas. Ionisation lowers the resistance between the main electrodes located at opposite ends of the tube, allowing an arc to be struck.

Initially, the tube emits a dull bluish discharge but as heat from the arc vaporises the mercury (and other metals) and the pressure increases, it changes to a brilliant white.

The heat also activates a bi-metallic strip, which shorts out the starting electrode after about 2-4 minutes. The starting cycle can take up to six minutes. If power to the lamp is interrupted, a cooling-off period of ten minutes or more is required before it can be restarted.

All metal halide lamps are designed to be "burnt" in a particular position for longest life. This is generally described as "base up" or "base down". Typically, high-wattage industrial lamps are powered directly from the 240VAC mains via a simple magnetic constant power ballast circuit.

In addition to the starting method described above, some metal halide lamps omit the starting electrode and just use a high-voltage pulse across the main electrodes to ionise the gas and strike the arc. Apart from eliminating the starting electrode, high-voltage starting also allows higher initial gas pressures. This provides faster run-up, better burn colour and quicker re-starting.

Gas-discharge headlights

Engineers had to overcome some major hurdles in order to bring high-intensity gas-discharge lamps to low-voltage, instant-use applications such as automobiles and battery-powered torches. For a start, about 85V is needed for the lamp supply. As well, the lamp needs to start immediately it is switched on and have useable light output within seconds, not minutes.

It also needs to be instantly restartable, with no cool-down period. All this has been achieved by re-engineering the basic lamp, along with some clever electronics. Here's how.

Gassing up

In order to obtain higher initial light output, the automotive metal halide arc tube is filled with Xenon rather than Argon. This fact hasn't escaped car enthusiasts who often use the name

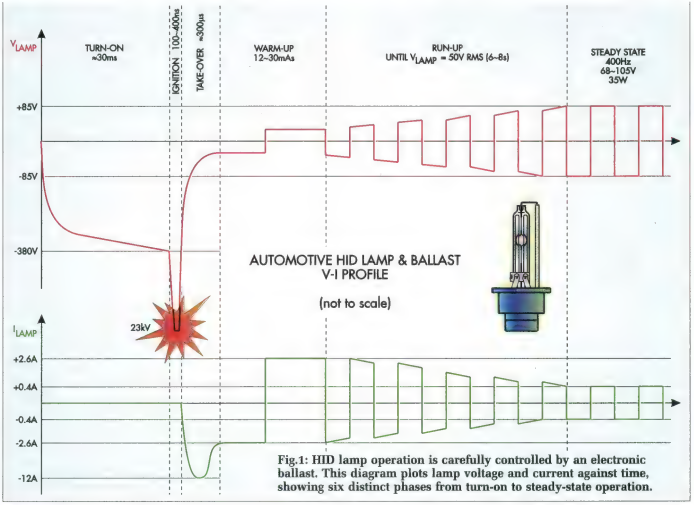


Fig.1: HID lamp operation is carefully controlled by an electronic ballast. This diagram plots lamp voltage and current against time, showing six distinct phases from turn-on to steady-state operation.

How good are HID headlights? These two shots compare conventional halogens with HIDs on low beam. The difference is quite spectacular! Notice how the light/dark cut-off appears about the same, but the view is much whiter and brighter (sounds like an Omo ad!) and there's a lot more side illumination. (Photo: Hella)

"Xenon" when referring to HID headlamps.

Xenon, by the way, is an odourless, colourless, tasteless, non-toxic, monatomic and chemically inert gas.

Although having markedly different dimensions, the lamps appear to operate in much the same way as their industrial counterparts. From the diagrams, you can see that the lamps retain all of the elements discussed above.

To date, manufacturers have standardised on several lamp styles, code named D1S, D1R, D2S and D2R. All four lamps are rated at 35W but the D1S and D2S versions produce 3200 lumens whereas the D1R and D2R produce 2800 lumens. The "R" versions have lower light output due to a black mask on the outer envelope. This is used to control light dispersion, which we'll talk about later.

To put these figures in perspective, a typical 55W tungsten-halogen lamp develops just 1000 lumens.

In addition, HID systems consume less power (about 45W; 35W + 10W in the ballast) than conventional lamps; in other words, about 20% less current drain for three times the light output.

The difference between the "D1" and "D2" versions can be seen in the base size. The D1 base is physically larger as it houses the igniter circuitry. In contract, the "D2" lamp requires an external igniter.

Lamp life

HID lamps are generally expected to last the life of the vehicle. With no filament to burn out, you might expect them to last forever but the arc tube does eventually "wear out" due to several unavoidable reactions.

In particular, tungsten from the electrodes gradually blackens the inside of the tube, a process that is greatly accelerated during cold starts. Manufacturers specify tube life at up to 3000 hours, which includes a "typical" number of cold starts. By comparison, tungsten-halogens have a life of between 700 and 1000 hours.

Electronic ballasts

To power a lamp from a 12V DC

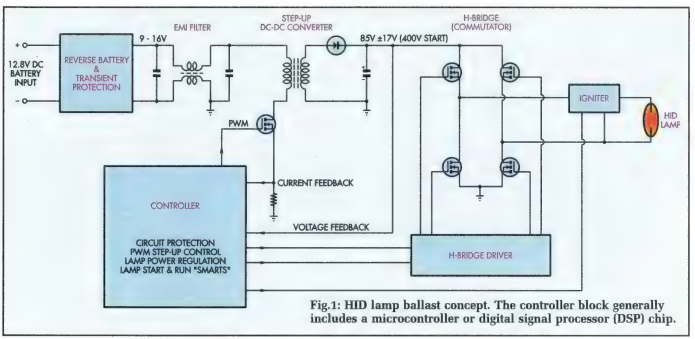


Fig.1: HID lamp ballast concept. The controller block generally includes a microcontroller or digital signal processor (DSP) chip.

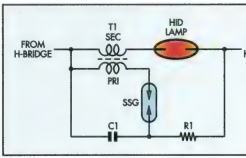


Fig.3: basic igniter circuit. When the breakdown voltage of the switching spark gap (SSG) is reached, it momentarily connects C1 across the primary of the trigger transformer (T1).

electrical system an electronic ballast is required. Fig.1 shows the basic layout of a typical 12V DC lamp ballast circuit.

The input voltage is first stepped up by a DC-DC boost converter. During normal running conditions, the voltage across the lamp needs to be between about 60V and 110V.

However, the open-circuit lamp (no arc) voltage can be as high as 600V. This high voltage is used by the igniter circuit (see Fig. 3) to generate the required 23kV ignition pulse.

Two transistor pairs in a H-bridge configuration apply the converter output to the lamp in an alternating fashion, with the resultant drive being a square wave of between 250Hz and 10kHz.

Power to the lamp is carefully regulated by the controller during all phases of operation.

This is where the "smarts" of the system are to be found. The lamp must be brought up to maximum output in the shortest possible time, while minimising electrode erosion.

This is achieved in five distinct phases, as follows:

1) Turn-on. Power is applied to the ballast and the controller commands maximum voltage from the boost converter. Within 30ms, the igniter is ready to fire the tube.

2) Ignition. One or more high-voltage pulses, at 20Hz repetition, are applied to the lamp to ignite the arc. If the arc is not struck after 20 pulses, a serious fault is assumed and the sequence is terminated.

3) Take-over. To maintain the arc but also conserve the electrodes, the controller regulates lamp power to 75W maximum at up to 12A. This high current surge lasts only about 300µs. During ignition and take-over, the H-bridge applies DC to the lamp so as not to "disturb" the arc.

4) Warm-up. The H-bridge performs one switching cycle, first applying a negative half cycle of 10ms duration, then a positive half cycle. Power input to the lamp is regulated to 75W at 2.6A maximum.

5) Run-up. The H-bridge begins switching symmetrically at about 400Hz. Until the lamp voltage reaches 50V, the controller regulates lamp power to 75W at 2.6A maximum. This takes about 6-12 seconds. During this time, lamp intensity rises to near its full rated output.

6) Steady state. Lamp power is regulated to 35W ±2W. Continuing regulation ensures that the light output remains constant, regardless of variations in battery and lamp voltages.

Of interest is the need to power the lamp from AC rather than DC. Apparently, applying a symmetrical square wave (ie, average = 0V) prevents electrolysis and other life-shortening effects within the arc tube.

A relatively low switching frequency (250Hz-10kHz) ensures circuit efficiency and avoids acoustic resonances that can occur at higher frequencies.

Igniter

To ignite the arc during a cold start, a pulse of about 5kV is required. For a hot start (re-strike), as much as 25kV is required to ionise the highly pressurised gas. This is achieved by a dedicated igniter circuit, as shown in Fig.3.

The igniter circuit is positioned in series with the lamp so as not to expose the ballast circuitry to high voltage transients.

When power is applied, capacitor C1 charges towards the full open-circuit ballast voltage (up to 600V). When it reaches the breakdown voltage of the switching spark gap (SSG), the SSG "flashes over", dumping the capacitor's charge into the primary side of the trigger transformer (T1). The voltage appears on the secondary side of the transformer multiplied many times over, resulting in more than 23kV across the lamp electrodes.

Packaging the parts

Although the lamps and bases conform to a standard, the same can not be said of the ballast, igniter and wiring harness. Generally, the ballast is

(Left): components of a Hella "Mark 4 Xenon" HID headlight system. The large metal box on the left houses the ballast, whereas the smaller box houses the igniter. A PES-type headlight (note the lens) appears at the rear. At right is a complete system, including washer and leveller, ready for installation. (Photos: Hella).

sealed in small metal enclosure which is mounted a short distance from the lamp socket. For D2S and D2R lamps, the igniter may be a separate black box or integrated within the ballast housing. Wiring harnesses are fully shielded, usually sealed and include high-voltage connectors for the D2S and D2R lamps.

Putting the light on the road

Equally important to lamp intensity is the ability to be able to direct the light exactly where it is needed.

Conventionally, this has been achieved with large parabolic reflectors and segmented glass lenses. In this simple system, the lens is mostly responsible for light distribution. High beam units also include a metal shield or mask that is used to provide the light/dark cut-off.

Also popular is the free-form (FF) reflector, which is characterised by a clear, rather than segmented lens. In this system, a complex-surface (segmented) reflector performs precise light distribution. Highly accurate placement of each individual segment is achieved with the aid of computer design software.

PES headlights

Recently, manufacturers have teamed complex-surface reflectors with optical projection technology to come up with the Poly-Ellipsoid System (PES) headlight. This system provides many advantages over other headlight systems.

For a start, projection allows precise definition of light/dark cut-offs, transition areas and contrasts with the use of an imaging screen. As well, only a very small light-emission surface is needed in comparison to conventional systems. This equates to smaller headlight enclosures, allowing vehicle designers to weave all kinds of magic with front-end styling.

Other tricks, such as signal image enlargement and light rings are used to reduce glare and provide better position marking.

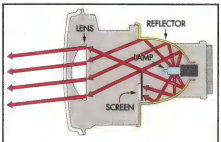


Fig.4: a poly-ellipsoid reflector and projection lens form the heart of the Bosch PES headlight. Dual-beam systems move the screen up and down with the aid of an electro-mechanical actuator.

HID lamps can be fitted to both reflection and projection systems. The masked HID lamps (D1R & D2R) are designed for reflection systems, whereas the clear lamps (D1S, D2S) go in the projection units.

Low/high beam solutions

To date, implementation of dual beam headlights has varied considerably among manufacturers. In some vehicles, halogen lamps are still used for high beam and HIDs for low beam.

However, the trend has been towards more complex systems that use a single HID lamp and some clever mechanical "beam adjustment" devices.

For example, the Bosch Bi-Litronic reflection system moves the lamp back in the reflector housing with an electromechanical actuator when low beam is selected. Thus, a completely different projection pattern is obtained for low and high beam positions.

Things get even tricker on projection systems. Once again, Bosch have developed a unique electromechanical solution. On their Bi-Litronic system, the position of the imaging screen is shifted to generate low and high beam light patterns.

Performance

Overseas studies have shown that HID headlights provide considerable safety improvements. In particular, more light to the sides of the road allows drivers to spot pedestrians and potential hazards much earlier, especially during poor weather conditions. The whiter light renders colours better too, making road signs and markings more visible.

It seems that drivers are impressed with this new system. A significant (and increasing) percentage of new-car buyers have been willing to part with over $1000 for what has mostly been offered as an optional accessory.

In 1997, European research institute Emnid carried out a survey among drivers whose vehicles were equipped with HID headlights. The results of this survey indicate that 94% of all HID users have a positive opinion of the new system. The main features highlighted were brightness (42%) and general illumination (35%).

HID controversy?

However, some road users have complained about the dazzling effects of these new headlights. Of course, having brighter headlights doesn't mean that we can "aim them up" to see further ahead; the light cut-off point remains the same.

However, up to that point, the light is much brighter and whiter. This means that for on-coming drivers, the familiar gradual fade from dark to light

About Lamp Efficiency

Throughout this article, we've listed lamp efficiency in percentage points, which is intended as a very rough guide only. The most common measure of lighting efficiency is calculated by dividing light output (in lumens) by the power input (in watts). The result is termed "lumens per watt". Since the value of lumens per watt is always greater than one, it is a measure of "efficacy", rather that "efficiency".

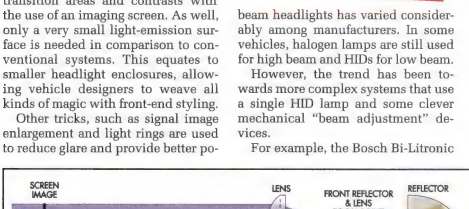
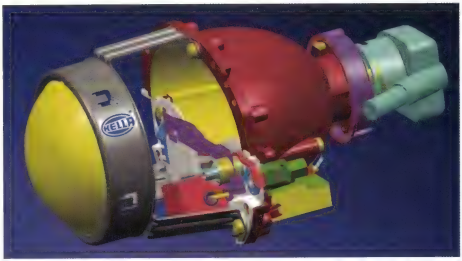


Fig.5: the basics of a headlight projection system. Operation is very similar to an overhead projector, with the projected image being a screen used to define the light/dark cut-off.



A 3-D model, coloured for clarity, of Hella's Bi-Xenon projection headlight. The imaging screen (grey, centre) is actuated by the electro-mechanical system in the foreground of the picture.

doesn't occur. Instead, there's a sudden jump to "bright" as the cut-off threshold is passed, and this could have a momentary dazzling effect.

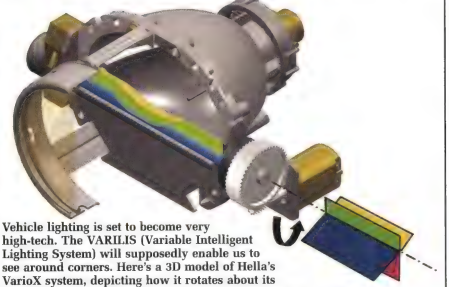
Doctors have put a slightly different spin on the problem. They say that while the human eye is sensitive to long-wave, red-yellow light during the day, at night the optic nerves are irritated by short-wave light, which is a component of the HID lamp spectrum.

European regulatory authorities are aware of the potential dazzling effects and have made automatic headlight levelling and cleaners mandatory on all vehicles fitted with HID headlights. Why cleaners? Well, dirty lenses were found to cause light scatter, another potential dazzler!

It appears that local car manufacturers will follow suit and fit automatic levellers and cleaners to Australian vehicles as the technology becomes available on less-expensive mounts.

Upgrading halogens to HIDs – is it possible?

One of the hottest car upgrades right now has to be HID headlights. A quick search on the net proves our point; there are literally hundreds of retrofit offers and for those that can't afford the $1000 (or more) price tags, there are cheap HID look-alikes.



Vehicle lighting is set to become very high-tech. The VARILIS (Variable Intelligent Lighting System) will supposedly enable us to see around corners. Here's a 3D model of Hella's VarioX system, depicting how it rotates about its longitudinal axis. Projection optics and special surface contours allow up to five different beam patterns to be projected onto the road. (Photo: Hella).

Be warned though – after-market HID headlights are illegal on most on-road vehicles! Factory-approved upgrades to some up-market European cars are possible but the rest of us will have to wait.

If you're hankering to take advantage of this new technology, then you still have a couple of options. HID auxiliary driving lights are available in Australia and can really make a difference to your night driving experience. Check out the Hella web site at www.hella.com.au to see what's on offer.

Still too pricey? The new Xenon-filled tungsten-halogen lamps are a good option for older vehicles. These generate up to 50% more light than the standard parts and are available in plug-in "H" series styles. They're legal, too.

Even the world's fastest production car, the Lamborghini Murciélago, gets the HID treatment. (Photo: Hella).

More reading?

If you'd like even more information on discharge lighting, SILICON CHIP has published several articles on the subject in the popular "Understanding Electric Lighting" series. Reprints of these articles are available for $8.80 inc p&p and GST:

"HID Lighting" – February 1999
"Metal Halides" – July 1998
"High Pressure Sodium" – June 1998
"Low Pressure Sodium" – April 1998

Credits

Thanks to Philips Automotive Lighting and Robert Bosch (Australia) for details of their HID lighting systems; Hella and DaimlerChrysler for photographs.

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With smart code-learning remote technology, this alarm protects doors, boot and bonnet. Features include a car body impact sensor, remote panic, flashing indicators and red dash light. This alarm is current-sensing and has central locking outputs.

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Case optional (H 2855)

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K 4210

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PIC Based LED Fun Kit

Have fun and learn about microcontrollers. One board lets you construct 8 different projects including a timer, dice roller, mini alarm and more. Supplied with buzzer, LEDs, programmed IC (PIC) and all components. Power supply: 3V DC.

K 3167

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Train Controller Kit

This easy to build and compact model train controller features pulse power for smooth low speed control. Supplied with PCB, case, hardware, front panel label and all components. Power source required: 18V DC 3A.

K 3020

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K 3203

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K 4209

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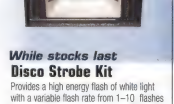

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Disco Strobe Kit

Provides a high energy flash of white light with a variable flash rate from 1–10 flashes per second. Power source: 240V AC. Supplied with components, hardware, PCB, deluxe plastic case, screened perspex front panel, linear 100mm Xenon tube and a commercial high-efficiency reflector.

K 3155

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K 3217

Silicon Chip Jun '01

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Mini Flasher Kit

For signage or parties. Uses just one 555 timer and one Mosfet. Strobe or flasher operation with adjustable flash rate. 20W or 50W halogens required. Power source required: 12V AC/DC.

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K 3074

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Can be used as an rpm indicator for electrical motors. Range adjustable from 400 – 4000 rpm. Supplied with components, hardware, PCB, case and front panel label. Power source: 9V battery required.

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Case optional (H 2481)

K 5606

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One chip, a sprinkling of components and a small motor combine to provide a spectacular light show. The Spin FX is a microprocessor-based LED display that can generate a wealth of psychedelic patterns. Supplied with PCBs, LEDs, a small DC electric motor, components, pre-programmed PIC and instructions.

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Case optional (H 2481)

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Cybug Solar Fly Kit

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Widgy

Distortion effects for

Do you own a guitar but don't have an overdrive (or distortion or fuzz) box yet? Well your prayers have been answered! This one sounds great, it's cheap and it's easy to build!

By PETER SMITH

If you're a guitar player, then you'll certainly know all about the various "effects" that can be used to enhance guitar sounds. Over the years, many great players have combined these effects with their own unique styles to create unmistakable signature sounds.

Some of the most sought-after sounds are produced by deliberate harmonic distortion of the music content. Originally, this type of effect was produced exclusively by overdriving the output stage of valve amplifiers.

About overdrive & distortion

These days, distortion effects are generated by dedicated electronics equipment. Perhaps in an attempt to capitalise on the success of past legends more than anything, much of this equipment boasts valve-like distortion qualities.

Valve amplifiers have a reputation for soft-clipping the output signal when they are overdriven, at least at moderate levels. If the signal is a pure sinewave, the peaks are simply rounded off, with a certain amount of wave shape compression occurring.

These rounded peaks create predominantly lower-order harmonics. Essentially, this means that the harmonics are closely related to the fundamentals and therefore tend to sound quite natural. Perhaps we could say that they "resonate" or "ring" with the fundamental tones.

Harmonics, by the way, are referred to as "partials" in the music world. They are simply some multiple of the original, fundamental frequencies.

Once the input to any amplifier is increased well beyond its design limit, the output signal is either hard clipped or transformed into indistinguishable noise, depending on the amplifier's overload characteristics.

Unlike the rounded peaks of a soft-clipped waveform, hard clipping is characterised by flat, sharp-edged waveforms. This is due to the output stages driving all the way to the power supply rails, slicing the peaks off and compressing, or "crunching", the signal.

Hard clipping results in many higher-order harmonics of the fundamentals. The resulting sound is often described as "reedy", "rather harsh" and "more metallic".

A side effect called "intermodulation distortion" occurs when all these harmonics inevitably mix. The product of two frequencies is both the sum and difference of the originals, and they may not necessarily be "musically" related to the content. Therefore, intermodulation distortion is unwanted noise that is quite easily detected by the ear.

Ideal distortion?

As far as we can discern, there is no easy way of generating the ideal distortion effect. Why? Primarily because it would be impossible to get broad

Box

our guitar

agreement on what that sound is. It has more to do with music type, personal preference and playing styles than the pure technicalities.

Many commercial distortion effects units combine both soft and hard clipping and user-accessible controls are included to provide adjustment between these two extremities, thus accommodating a range of music and styles. Some also include tone controls for increased versatility.

The SILICON CHIP "WidgyBox" (like the name?) is based on these ideas. The design criterion was simple: it had to be uncomplicated, low-cost and easy to build. We think it will make a worthwhile addition to any guitarist's basic effects line-up.

Reproducing the sound

Now for the $64 question: if valve amplifiers already produce the desired sound, then why bother trying to reproduce it? Why not just use a valve amplifier?

Well for a start, valve amplifiers are expensive. In addition, they need to be over-driven to produce the effect. This means lots of volume, which can obviously be a real problem. In the words of one disaffected player, "I have good tone when I play loud but I get kicked out of clubs and bands".

Dedicated effects boxes (also known as "effects pedals" and "stomp boxes") address these issues. They create the desired effect before the amplifier input, allowing the musician to play at any volume. They also allow easy experimentation for those in search of a unique sound. What's more, you don't need a valve amplifier – a (much) cheaper solid-state amplifier will suffice!

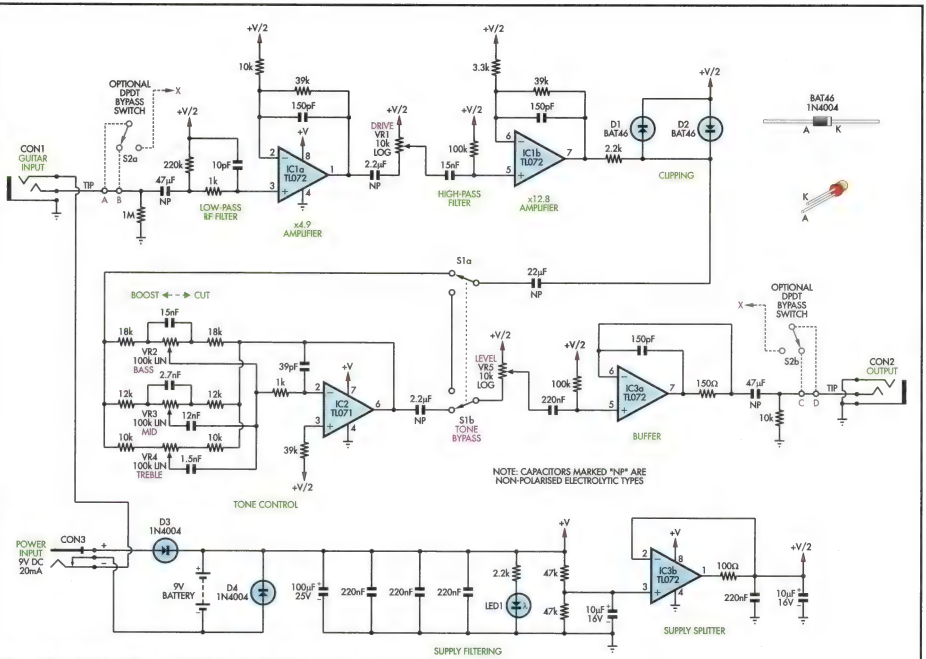
MAIN FEATURES

- Low cost.
- Easy to build.
- Battery-powered.
- Adjustable distortion.
- Three tone controls.
- Optional stomp switch.

How it works

Fig.1 shows the details of our design – it's based entirely around the TL07x series op amps. Like most effects pedals, the circuit is designed to connect directly in-line with the guitar's output.

A 47µF capacitor AC-couples the input to the first op amp stage (IC1a). This capacitor is much larger than you might expect in order to ensure low noise performance. As with all



"WIDGYBOX" GUITAR DISTORTION EFFECTS

SC ©2003

Fig.1: the circuit uses three low-cost op amps (IC1-IC3) and operates from a 9V battery. Schottky diodes D1 & D2 provide the soft clipping function, while IC1b provides hard clipping, depending on the setting of VR1.

the following stages, IC1a's input is biased to one-half the supply rail voltage (+V/2), in this case via a 220kΩ resistor. The 1kΩ resistor and 10pF capacitor at the input act as a low-pass filter, preventing RF (radio frequency) signals from being coupled into the circuit.

IC1a is wired in a non-inverting configuration with a gain of 4.9, as set by the 39kΩ and 10kΩ feedback resistors. The 150pF capacitor in the feedback path rolls off the frequency response above the audio spectrum.

The output of IC1a appears at pin 1 and is AC-coupled via a 2.2μF capacitor to Drive pot VR1. This pot controls the signal level into the next stage, for reasons that will become clearer shortly.

The signal from the VR1's wiper is in turn AC-coupled to op amp IC1b via a 15nF capacitor. This capacitor also acts with a 100kΩ bias resistor to form a high-pass filter, to provide a small measure of pre-distortion equalisation. This is necessary to reduce the effects of harmonics from the lower strings. Apparently, these low frequency harmonics tend to sound a little "fruity" during chord work.

In addition, cutting the low end response may also help with guitar pickup equalisation.

IC1b is configured as a non-inverting stage and operates with a gain of 12.8. It has two important roles, the first being to drive a pair of back-to-back diodes (D1 & D2) whose job it is to perform the soft clipping function.

Clip job

The way that this works is quite straightforward. Once the peak signal level exceeds the forward voltage (0.2–0.4V) of the diodes, they start to conduct, thus clipping the highs and lows off the waveform. In addition, the non-linear conduction characteristic of the diodes give the peaks a smooth, rounded appearance.

Regardless of increasing drive level, the diodes continue to clip the signal to about the same voltage, resulting in even more waveform compression (and distortion).

At very high drive levels, IC1b's second role comes into play – it starts to hard clip the signal. What happens

Effects Bypassing: The Different Methods

Generally, it's desirable to be able to switch effects in and out during a performance. A popular means of doing this is via a foot switch built into the same box that houses the electronics. This arrangement is part of all commercial effects pedals.

Another common method relies on a dedicated bypass box, which is simply wired in series with the effects input and output leads.

In the latter approach, the bypass function physically switches the effects box out of the signal path. This is termed "hard" bypassing, as opposed to "soft" bypassing, where some part of the effects electronics is still in-circuit (usually an input buffer and/or line driver).

"Hard" bypassing is a popular approach because it ensures that the effect has no impact whatsoever on the signal, especially in relation to loading or otherwise distorting the signal source. A good example of a do-it-yourself bypass box can be found on the web at **www.geofex.com/Article_Folders/Millenium/millen.htm**

Alternatively, the WidgyBox has provision for an internal DPDT "hard" bypass switch. It's simply a matter of removing the two wire links adjacent to the input and output sockets and wiring up switch S2 as shown on the circuit diagram (Fig.1).

We envisage an internal switch being used in conjunction with a more robust ("stomp proof") metal case!

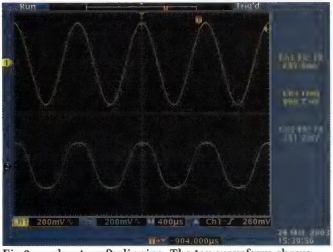


Fig.2: moderate soft clipping. The top waveform shows the signal into op amp IC1b, while the bottom waveform shows the signal across the clipping diodes (D1 & D2). Note the smooth waveform peaks. Compression is already quite noticeable, nearing a 2:1 ratio.

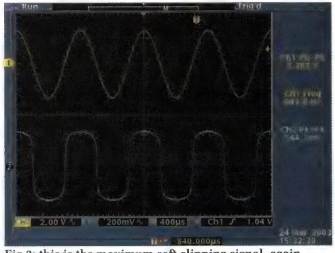


Fig.3: this is the maximum soft clipping signal, again taken across diodes D1 & D2. Note that the rising and trailing edges are almost vertical now but we still have rounded peaks. The compression is now quite high and this also imparts quite a degree of sustain.

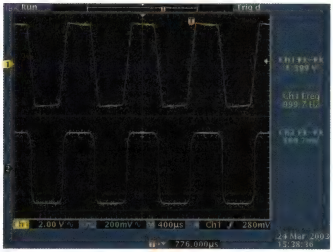


Fig.4: maximum hard (and soft) clipping. The top waveform shows the hard-clipped op amp output. At the bottom, we can see what it looks like across the diodes. The amplitude isn't much different to Fig.3 but the peaks have been "flattened".

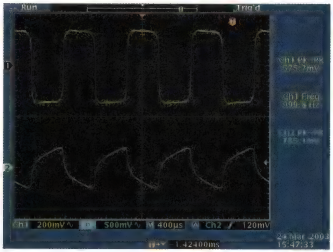


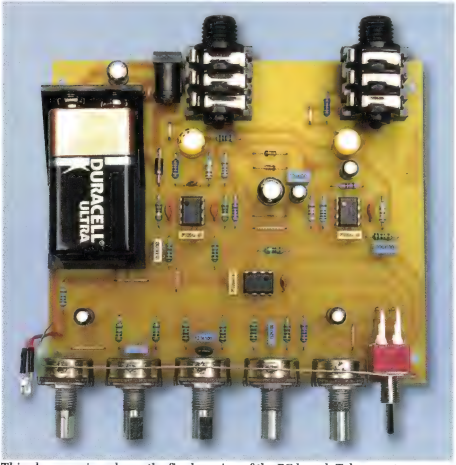
Fig.5: fiddling with the tone controls has a bigger effect than you might expect, because it's boosting or cutting the harmonics as well. Here's what the output of the box looks like (bottom waveform) when we wind up the bass boost.

is that the amplified signal level exceeds the op amp's maximum available output swing – so it is abruptly clipped.

This is normal behaviour for any over-driven op amp and it's exactly what we need for our hard clipping function!

As a matter of interest, the TL072 clips non-symmetrically. This suggests that not only do we get the higher-order harmonics mentioned earlier but also a larger proportion of even rather than odd multiples.

Note that we've specified Schottky diodes for D1 & D2 as they have a lower forward voltage than the common 1N4148/1N914 varieties. This gives a larger adjustment range between soft and hard clipping, allowing more waveform compression and increasing the "sustain" effect.



This close-up view shows the final version of the PC board. Take care to ensure that all polarised parts are installed the right way around.

Tone controls

The distorted signal is routed to a Baxandall type tone control network, based around op amp IC2 and potentiometers VR2, VR3 & VR4.

These pots and their associated resistors and capacitors form the feedback network between the op amp's inverting input and its output.

Each of the bass, mid and treble networks can be considered separately since they are connected in parallel between the signal input following IC1b and the output of IC2 at pin 6. Furthermore, the wiper of each pot is effectively connected to the inverting input (pin 2) which is a virtual ground.

Operation of the bass control is as follows: with VR2 centred, the value of resistance connected between the output from IC1b and pin 2 of IC2 is the same as that between pins 2 & 6 and this sets the gain to -1. The 15nF capacitor has no effect since it is equally balanced across the potentiometer.

If we move the wiper of VR2 to the full boost position (ie, rotate the pot shaft fully clockwise), we get 19kΩ

Table 2: Capacitor Codes

Value	µF Code	EIA Code	IEC Code
220nF	0.22µF	220n	224
100nF	0.1µF	100n	104
15nF	.015µF	15n	153
12nF	.012µF	12n	123
2.7nF	.0027µF	2n7	272
1.5nF	.0015µF	1n5	152
150pF	150pF	150p	150
39pF	39pF	39p	39
10pF	10pF	10p	10

(18kΩ + 1kΩ) between the input and pin 2 of IC2 and 119kΩ between pins 2 & 6. In addition, the 15nF capacitor is across the 100kΩ resistance in the feedback loop.

Without the capacitor the gain would be -119kΩ/19kΩ or -6.3 at all frequencies. But with the capacitor, the gain is high only at around 50Hz and as the frequency rises it comes back to -1 (ie, overall unity gain). Thus we have bass boost.

Conversely, when VR2 is wound fully anticlockwise, the position is reversed and we get a gain of 19kΩ/119kΩ or -0.16 (-16dB). The capacitor is now on the input side and provides less gain at frequencies below 100Hz but with gain increasing to -1 at frequencies above 100Hz. Thus we have bass cut. Various settings of VR2 between these two extremes will provide for less boost and cut.

The midrange section works in a similar manner except that there is now a 12nF capacitor between VR3's wiper and pin 2. This, along with the 2.7nF capacitor across VR3, gives a bandpass filter, so we either boost or cut the midrange frequencies.

The treble control operates with no capacitor across VR4 but with a 1.5nF capacitor between its wiper and pin 2 to produce a high frequency boost or cut at 10kHz.

A 39pF capacitor between pins 2 & 6 of IC2 provides a high-frequency rolloff to prevent oscillation which could otherwise occur when the tre-

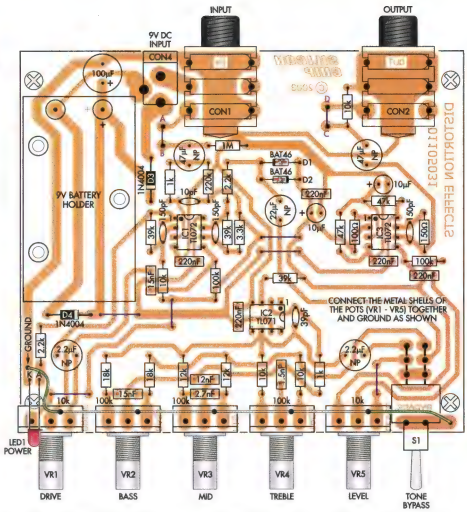


Fig.6: here's how to install the parts on the PC board. Install the smaller parts first before moving on to the output sockets, the battery holder and (finally) the pots (see text).

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	3	39kΩ	orange white orange brown	orange white black red brown
❑	2	18kΩ	brown grey orange brown	brown grey black red brown
❑	2	12kΩ	brown red orange brown	brown red black red brown
❑	3	10kΩ	brown black orange brown	brown black black red brown
❑	1	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	150Ω	brown green brown brown	brown green black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown

Parts List

1 PC board coded 01105031, 117mm x 100.5mm
1 110 x 140 x 35mm (L x W x H) plastic instrument case (Jaycar cat HB-5970)
1 DPDT PC mount toggle switch (S1) (Jaycar ST-0365)
2 6.5mm PC-mount stereo switched sockets (CON1 - CON2) (Jaycar PS-0190)
1 2.1mm PC mount DC socket (CON3)
1 9V PC mount battery holder
3 100kΩ 16mm PC mount linear pots (VR2 - VR4)
2 10kΩ 16mm PC-mount log pots (VR1, VR5)
5 knobs to suit pots
20mm length of small heatshrink tubing
70mm length of light duty hook-up wire
320mm length of 0.71mm tinned copper wire

Semiconductors

2 TL072CP dual op amps (IC1,IC3)
1 TL071CP op amp IC (IC2)
2 BAT43 schottky diodes (D1, D2) (Jaycar ZR-1141)
2 1N4004 1A silicon diode (D3,D4)
1 3mm high-brightness red LED (LED1)

Capacitors

1 100µF 25V PC electrolytic
2 10µF 16V PC electrolytic
2 47µF 16V non-polarised PC electrolytic (Jaycar RY-6820)
1 22µF 16V non-polarised PC electrolytic (Jaycar RY-6816)
2 2.2µF 16V non-polarised PC electrolytic (Jaycar RY-6804)
5 220nF (0.22µF) 50V MKT polyester
2 15nF (.015µF) 50V MKT polyester
1 12nF (.012µF) 50V MKT polyester
1 2.7nF (.0027µF) 50V MKT polyester
1 1.5nF (.0015µF) 50V MKT polyester
3 150pF 50V ceramic disc
1 39pF 50V ceramic disc
1 10pF 50V ceramic disc

Resistors (0.25W, 1%)

1 1MΩ	3 10kΩ
1 220kΩ	1 3.3kΩ
2 100kΩ	2 2.2kΩ
2 47kΩ	2 1kΩ
3 39kΩ	1 150Ω
2 18kΩ	1 100Ω
2 12kΩ	

ble control is set for maximum boost. Similarly, the 1kΩ resistor in series with pin 2 is there to attenuate RF signals; it stops radio breakthrough.

Being able to boost or cut the distorted signal in three distinct bands gives you a lot of control over your sound – more, in fact, than is possible with many commercial units, which commonly provide only one or two bands of adjustment.

Switch S1 has been included to allow you to quickly bypass the tone circuitry altogether should you wish to control it elsewhere in your setup.

Level control & output

IC2's output is AC-coupled via a 2.2µF capacitor to VR5. This pot allows you to set the output level to match the input, thus preventing any noticeable jump in volume when the WidgyBox is switched in and out (see the panel entitled "Effects Bypassing: The Different Methods"). From there, the signal is AC-coupled via a 220nF capacitor to op amp IC3a. This op amp is configured as a voltage follower – it simply buffers the incoming signal and passes it through unchanged.

A 150Ω resistor decouples IC3a's output from any cable capacitance, thereby ensuring stability under all conditions. This is followed with a 47µF capacitor to remove the DC offset. Finally, a 10kΩ resistor terminates the output to ground, ensuring that there are no nasty clicks when the box is hot-switched into the signal path.

Power supply

In keeping with other popular effects pedals, power for the unit is provided by a 9V alkaline battery. The current drain is only about 12-15mA, so you'll get more than a days' continuous use and many days of intermittent use before a swap is required.

Alternatively, power can be provided by a 9V DC plugpack. Be aware, though, that most unregulated plugpacks put out much more voltage than their rating at these low current levels.

Although this won't damage your box, the higher voltage will alter the

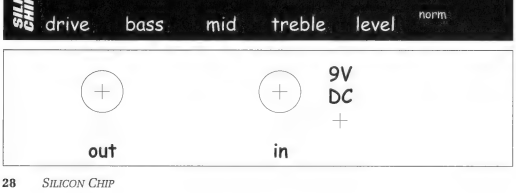


Fig.7: these full-size artworks can be used as drilling templates for the front and rear panels. Drill small pilot holes to begin with, then carefully enlarge each hole to size using a tapered reamer.

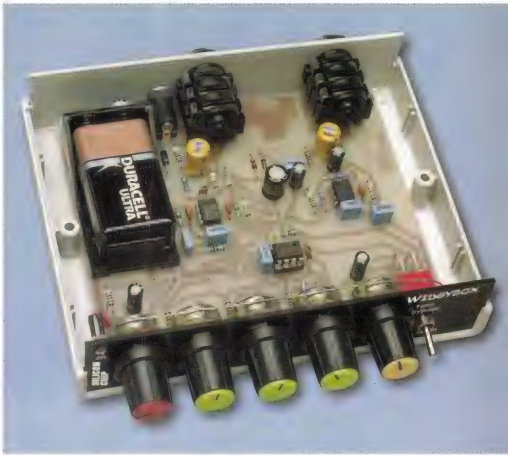
characteristics of the distortion effects at high drive settings.

If you have a plugpack with selectable output voltages, you may find that the 7.5V setting provides about 9.5V under light load, which is ideal.

Note that the negative terminal of the battery connects to earth via the switch contacts of the DC input socket (CON3) and the middle and common contacts of the guitar input socket (CON1). This means that you'll need to plug in your guitar to power up the box.

It also means that when a plugpack jack is inserted, the battery is disconnected. This feature is very important, otherwise the plugpack would attempt to charge the battery and that could have loud and startling consequences!

Finally, the half supply voltage rail (ie, +V/2) needed by all of the bias networks is generated by op amp IC3b and its associated circuitry. Two 47kΩ resistors divide the +V rail in half, after which it is filtered by a 10µF capacitor and then buffered by op amp IC3b. A 100Ω resistor in series with IC3b's output decouples the large 10µF filter capacitor.



The assembled PC board fits neatly into a low-profile plastic instrument case. Note that the PC board shown here is a prototype version and differs slightly from the final version shown in Fig.6.

Construction

With the exception of the power LED, all components mount on a single PC board, coded 01105031. Using the overlay diagram in Fig.6 as a guide, begin by installing the eight wire links using 0.7mm tinned copper wire or similar. Note that the two links adjacent to the input and output sockets (CON1 & CON2) can be left out if you intend fitting a foot switch to the box but more on that later.

Install the low-profile components first, beginning with the resistors and diodes (D1-D3). Follow with the three op amp ICs (IC1-IC3). Make sure that you have the pin 1 (notched) end of each IC oriented as per the overlay diagram. In addition, note that IC2 is a TL071 (single) op amp, whereas the others are TL072 (dual) versions. Don't mix them up!

The two jack sockets (CON1 & CON2) and the DC socket (CON3) can go in next. When inserting the jack sockets, push them all the way down until the shoulders of all pins make contact with the PC board surface. Follow with the battery holder, which should be secured to the PC board with No. 4 x 6mm self-tapping screws prior to soldering.

Next, install all the capacitors. The 100µF and two 10µF electrolytic capacitors are polarised and must go in the right way around. The remaining five electrolytics are non-polarised (marked "NP" on the overlay) and can go in either way.

Potentiometers VR1-VR5 and switch S1 should be installed last of all. Start with VR1 but solder its middle pin only. Lift the board to eye level and examine the position of the pot from the front and side. It should be sitting perfectly "square".

Why bother? – well, when we eventually fit the front panel, this step helps to ensure that all the pot shafts are aligned, improving appearance and

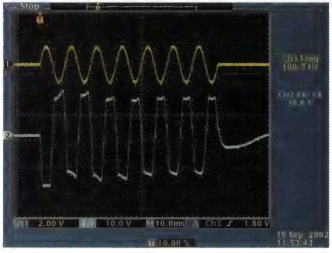


Fig.8: having heard all the stories about valve distortion, we were consumed with curiosity and had to have a look at it ourselves. A kind gentleman loaned us his valve guitar amplifier and we captured this waveform when it was overdriven. Man, that doesn't look too soft, does it?

The rear panel carries the 6.5mm stereo switched sockets and includes an access hole for the DC power socket. Note that the PC board in this photo is the final version, as shown in Fig.6.

minimising stress on solder joints when the nuts are tightened.

Adjust the pot position as necessary and then solder the remaining two pins. Repeat this procedure for the other four pots.

Finally, install the tone bypass switch (S1), ensuring that it is seated firmly on the PC board surface before soldering

Case preparation

As supplied, the bottom half of the case contains eight mounting posts. The four outermost posts are used to support the PC board, while the four inner posts are not required and must be removed. This can be done using a chisel or an oversized drill bit.

The templates shown in Fig.7 provide the quickest and easiest method of getting all the holes in the right places for the front and rear panels. Photocopy the templates, cut them out and carefully align and tape each one to a blank panel.

First, gently centre-punch the holes directly through the templates, then remove them and drill 1mm pilot holes for each mark. Don't attempt to jump directly to a large diameter drill, as you may split a panel or get the holes off-centre. Instead, drill the holes progressively larger in several steps.

Some constructors won't have fractional drill sizes all the way up to the large diameters of the pot shafts and jack sockets. In this case, a tapered reamer is ideal for enlarging the holes to their final sizes.

Trial fit

The front panel should not be forcibly fitted over the pot shafts. If the holes are correctly sized for the shafts but the panel is still a tight fit (or won't fit!), then the holes are obviously out of alignment. Increase the hole sizes as necessary to get an easy fit. This is quite important; a good fit keeps all the pot shafts in alignment.

With the drilling done, slide the panels into place and loosely install washers and nuts on all the pots and the two jack sockets. The assembly should now slip home in the case bottom without too much trouble. Check that you can sight the four mounting post holes through the PC board holes and that the posts actually make contact with the underside of the board. If all is well, tighten up the nuts by hand.

Grounding the pots

To minimise extraneous noise, the metal shells of the pots must be connected to the ground (0V) rail. This is achieved by soldering a single length of tinned copper wire to the metal top of each pot and terminating it to the

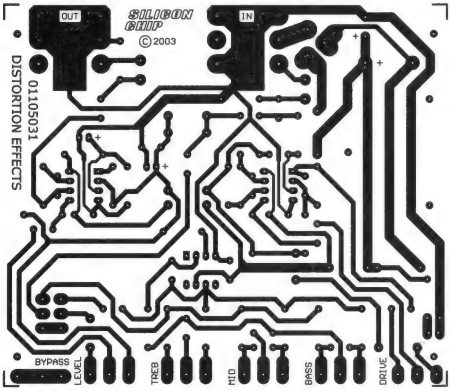


Fig.9: this is the full-size etching pattern for the PC board.

PC board at either end. The overlay diagram (Fig.6) and the various photos show where to position this wire.

In order to get the solder to adhere to the pots, remove a small spot of the cadmium plating on each pot with an ink rubber or scouring pad and clean the area with alcohol. That done, pre-tin the spot with a fairly hot iron and large gauge multicore solder before attempting to attach the earth wire.

Installing the LED

To mount the LED, first strip and tin the ends of two 30mm lengths of light-duty hook-up wire. That done, shorten the LED leads to about 8mm, solder one end of each wire to a LED lead and insulate the connections with heatshrink tubing.

Finally, slip the LED into position in the front panel and solder the two leads to the PC board as shown in Fig.6. Be sure to install the LED with the correct polarity, though. The flat edge on the LED body goes towards the edge of the case (see Figs.1 & 6).

If necessary, the LED can be fixed in position with a spot of glue or silicone sealant.

Testing

A few quick voltage measurements around the circuit will help to confirm that your project is ready for use. You'll need a fresh 9V battery, a mono jack plug and a multimeter.

Fit the battery and insert the plug in the input socket (CON1). The plug can be on one end of your guitar lead but don't connect anything to the other end just yet!

As soon as the plug is inserted, the power LED should light. If it doesn't, then remove the plug immediately and check the orientation of the LED. Also, check that there is continuity through the DC socket (CON3) switch contacts, which can be identified by tracing the negative connection from the battery.

If the above checks don't identify the problem, then suspect a short or low resistance between the +V rail (battery positive) and ground (battery negative). You may have inadvertently reversed one of the ICs or perhaps there is a solder bridge between tracks somewhere. Follow the +V trace around the board to track it down.

OK, let's assume your LED lights up. Next, we'll check that power arrives at each op amp IC supply pin.

Set your multimeter to read DC volts and measure between pins 4 & 8 of both IC1 and IC3. That done, repeat this measurement between pins 4 & 7 of IC2. In all cases, the reading should be about 9.2V.

Now touch the negative probe of your meter to the negative battery terminal and the positive probe to pin 2 of IC2. Your reading should be very close to half the voltage measured above (about 4.6V).

Final touches

The next step is to secure the PC board to the case posts with four No. 4 x 6mm self-tapping screws. Before tightening the screws, it's a good idea to temporarily loosen off the pot and jack socket nuts, so that the assembly settles "comfortably" into position.

The final job is to shorten the pot shafts to match the knobs. Before doing this, screw the top half of the case into position and tighten up all of the pot nuts.

The procedure now is to grip the tip of each pot shaft (in turn) in a vice, starting with VR1. You can then carefully cut off the unneeded section of the shaft using a hacksaw. For our prototype, only 14mm of shaft length (measured from the surface of the panel) was required for the push-on type knobs. Be sure to support the weight of the assembly during the cutting.

That's it – you're ready to rock!

Credits

Many thanks to Tim and Ash who were kind enough to drop in and put the prototype through its paces. **SC**

Sound Fun: Experimenting With The Circuit

Like to experiment a little? Then check out these ideas!

As explained in the text, the high-pass filter formed by the 15nF capacitor and 100kΩ resistor at the input of IC1b provides for some pre-distortion equalisation.

The 3dB point of this filter is around 100Hz. A higher or lower point may better suit your system. We suggest an upper limit of about 300Hz (no lower limit). Here are some example values: for a 194Hz 3dB point, use 8.2nF instead of 15nF; for 284Hz, use 5.6nF.

It is also possible to experiment with the distortion-making section of the circuit. For example, replacing one of the Schottky diodes with a common 1N4148 will create non-symmetrical clipping for quite a different sound. You could also substitute germanium diodes, which have softer turn-on characteristics. Have fun!

Help – It Doesn't Work!

Before doing anything else, double-check all component values against the overlay diagram. If that doesn't turn up anything, then some detective work is in order.

If you have no output at all, then a few additional DC voltage measurements may help to narrow the problem down to a particular op amp and/or it's immediate circuitry.

Apply power and wait at least 10 seconds for the bias networks to fully charge. Don't apply a signal to the input or connect anything to the output socket during these checks.

Connect your multimeter's negative probe to battery negative and touch the positive probe to each op amp output in turn (IC1a pin 1, IC1b pin 7, IC2 pin 6 and IC3a pin 7). Although the readings will vary slightly, they should all be close to one-half battery voltage. A large variation in any reading indicates a problem in the immediate vicinity.

Alternatively, if you have output signal but varying the drive pot doesn't change the distortion level, then suspect a problem with the feedback circuitry around IC1a or IC1b.

Direct Digital Synthesis (DDS) makes it very easy to design a low-cost, high-performance function generator – one of the handiest pieces of test gear you can have. This one can be set to any specific frequency between 1Hz and 10MHz and offers both sine and square wave output.

The 20MHz Low Cost Function Generator I described in the August 96 issue of "Electronics Australia" has proven very popular, with thousands having been built. The low cost, simple construction and wide bandwidth made it a very attractive project.

However, there were two problems with that design – the lack of a frequency display and being able to set the frequency to exactly what you wanted. To overcome these, one kit supplier bundled the function generator with another frequency counter kit.

So it is not surprising that many people have asked for an updated design with a built-in frequency display. While a frequency display would be relatively easy to add, it would add significantly to the cost and complexity of the project. In addition, the analog nature of the original design meant that temperature drift would also be an issue.

This new design overcomes these problems by adding a frequency display and digital frequency selection, while still maintaining the low-cost approach.

The design

The design is based on an Analog Devices AD9835, a complete 50MHz

by David L. Jones*

(clock) Direct Digital Synthesis (DDS) sinewave generator on a single chip.

The MAX038 used in the previous design is analog in nature and setting the exact output frequency is difficult unless you have many ranges with fine adjustment.

Going digital with the DDS chip is the obvious way to go: it allows you to set the output frequency exactly from 1Hz to 10MHz in 1Hz steps and there is effectively no drift with temperature or time as the output frequency is crystal-locked.

As the AD9835 is clocked at 50MHz, in theory it is capable of generating a sinewave up to 25MHz. At this frequency, the output waveform quality is more difficult to control and amplify, so 10MHz was taken as the arbitrary upper limit.

This results in a good quality, low distortion, large output signal level over a 0-10MHz range.

While 10MHz is not as high as the 20MHz+ in the original design, it is still sufficient for most applications and is way beyond the 2MHz or so of most commercial analog bench generators.

LOW COST 1HZ – 10MHZ DDS FUNCTION GENERATOR

It's a tiny, tiny chip!

Unfortunately, the AD9835 DDS chip is only available in a 16-pin TSSOP (Thin Shrink Small Outline Package) surface-mount package, which makes it challenging(!) to solder by hand.

A TSSOP package has half the pin pitch of your typical SOIC surface mount IC package, a mere 25-thou (0.635mm). Compare it with the 74HC14 SO14 package also used in this design. More will be mentioned about how to solder this device later.

There are other DDS chips in the Analog Devices DDS product range with easier-to-handle packages but they are much bigger, more expensive and don't have a nice serial interface like the AD9835.

My first prototype for this design used an LCD panel for the frequency readout but this would have significantly increased the cost of the project. So I thought about it for a while and came to the realisation that you don't really need to display the entire frequency at any one time. It's nice – but by no means essential.

To set and display the frequency you really only need to display one digit at any one time, in which case a single 7-segment LED display can be used.

You do need some other indication to tell you what digit you are setting – but a simple LED can do that.

The end result is a single 7-segment LED display with a row of 3mm LEDs to indicate which digit of the output frequency is being displayed and set. So the row of LEDs correspond to X,XXX,XXX Hz.

Our frequency display is now one-tenth the cost of an LCD and is easier to assemble.

To also help reduce the cost, the PC board has been designed to fit into a standard UB3 Jiffy box, with no wiring required – everything mounts on the PC board.

RCA output connectors were chosen in preference to BNC connectors, as the PC board mounting RCA connectors are about one-tenth the cost of the BNC type.

In fact, you can buy a PC board mounting RCA connector plus an RCA-to-BNC convertor for less than the cost of a BNC PC board mount connector.

Specifications:

Waveform Generation:	32-bit DDS, 10-bit DAC
Distortion:	<1% at 1kHz
Frequency Range:	1Hz to 10MHz in 1Hz steps
Frequency Display:	"Sliding Window" 7 digit (EEPROM frequency retention)
User Input:	Three push buttons
Sinewave Output:	0.5Vp-p adjustable, 50Ω
Squarewave Output:	CMOS/TTL compatible, 50% duty cycle
Output Connections:	RCA
Power:	9VAC 100mA plugpack

Main controller

A PIC16F628 8-bit microcontroller was chosen as the main controller. It has 2KB of internal FLASH program memory, 224 bytes of RAM and 128 bytes of EEPROM. This is adequate for our control program and data storage.

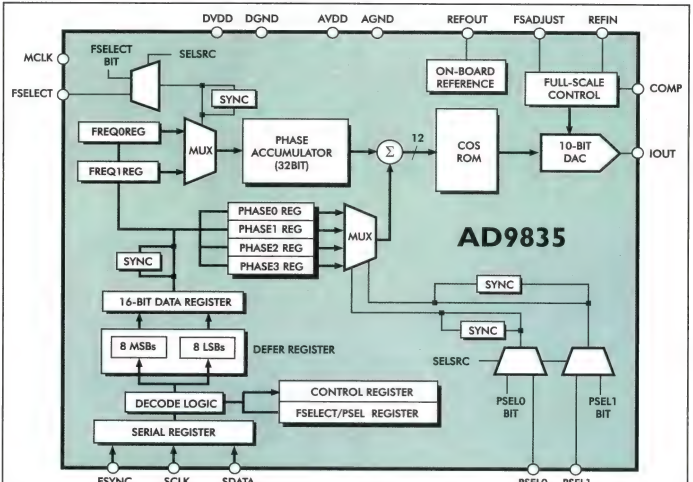


Fig.1: inside the AD9835 DDS IC. Its operation is explained in the text. On the facing page is Fig.2, the circuit diagram.

This chip serves three purposes. One is to control the display and switches, the second is to send the necessary control commands to the AD9835 DDS chip and the third is to store the output frequency in the internal EEPROM.

The frequency set by the user is stored in the internal EEPROM and this same frequency is automatically set when the project is next powered up.

The 4MHz internal RC oscillator is used to lower system cost and to free the extra pins for I/O functions. There are no critical absolute timing requirements in the project, so a crystal oscillator is not required.

How DDS frequency generation works

The internal block diagram of the AD9835 (Fig.1) shows its operation as well as that of a basic Direct Digital Synthesis (DDS) generator. A DDS generator consists of three major components – a phase accumulator, a sine-wave lookup table (usually contained in ROM) and a digital-to-analog convertor (DAC). The phase accumulator is also commonly referred to as a Numerical Control Oscillator (NCO), although no part of a DDS actually "oscillates".

As sinewaves are non-linear in nature, they are not that easy to generate accurately, even using standard sampling techniques. On the other hand, the "phase" of a sinewave is completely linear in nature, from 0-360°, and thus lends itself to be more easily generated.

Using a reference clock and the linear aspect of the phase, a DDS generator can generate very accurate sinewaves of almost any frequency, completely in the digital domain.

The phase accumulator basically performs an integration function and generates a linear phase "ramp" in proportion to the desired frequency, which is contained in the 32-bit register FREQ0. The sine (or cosine in the case of the AD9835) lookup table converts the linear phase ramp into a sinewave.

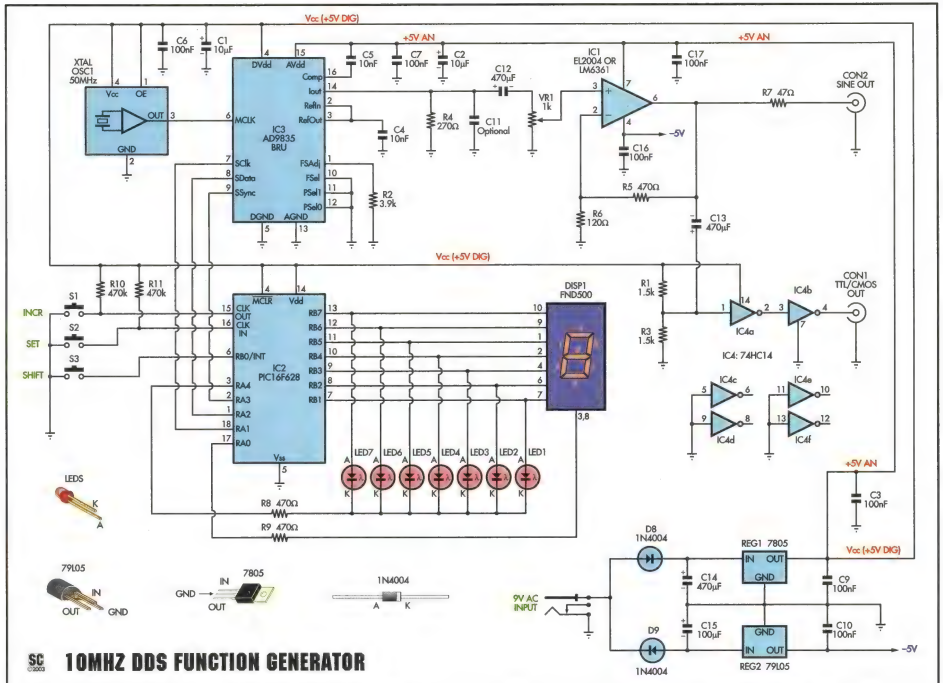
As sinewaves are completely symmetrical every 90°, the lookup table only needs to store one quarter of the waveform, with some appropriate control logic to map this over the full cycle. (Different DDS devices have differing ways to do this).

Even though the AD9835 contains a 32-bit frequency control register, a 32-bit (2^{32} memory bits) lookup table is not required, as the AD9835 only has a 10-bit DAC.

So the (co)sine lookup table does not need to be much more accurate than this; in this case it is only 12 bits. This ensures that the accuracy of the signal is determined entirely by the DAC resolution and linearity.

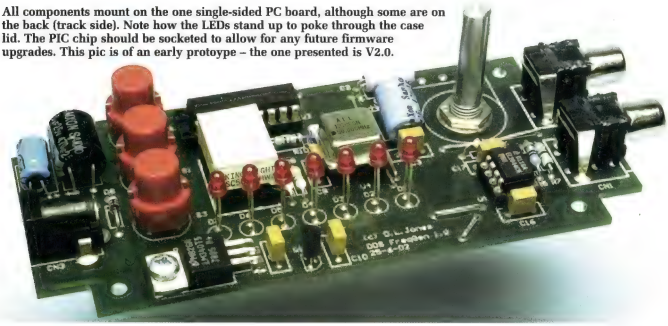
How it works:

As you can see from the schematic (Fig.2) there isn't much to the design. IC3 does all the frequency generation, IC2 handles the control and display, while IC1 and IC4 provide output drive.



10MHZ DDS FUNCTION GENERATOR

All components mount on the one single-sided PC board, although some are on the back (track side). Note how the LEDs stand up to poke through the case lid. The PIC chip should be socketed to allow for any future firmware upgrades. This pic is of an early protoype – the one presented is V2.0.



IC3 is programmed by a custom 3-wire serial control bus from the microcontroller (IC2). Data and commands are transferred in 16-bit words. The serial interface is run asynchronously to the main clock and can be run at any speed determined by the host micro.

IC3 has various modes and internal registers that must be defined before it will output a frequency, and these are explained in the data sheet for those who are curious. IC3 is also capable of frequency and phase modulation of the output signal, both of which can be controlled by either the serial bus or an external pin. For the sake of simplicity and cost reduction, these features have not been implemented into this design.

The actual output frequency is determined by the value in the 32-bit FREQ0 register. The value in FREQ0 will be equal to $F/(50MHz/2^{32})$, where F is the desired output frequency.

From this equation you will see that with our 50MHz oscillator we can get approximately 12mHz resolution and this value will also equal our output frequency uncertainty (ignoring crystal accuracy). In the case of a 1Hz output frequency, the FREQ0 register will contain the value 86 which equates to 1.001Hz, not quite 1Hz but close enough!

At the low end of the frequency range the frequency accuracy will be 0.1% worst case, while at the high end the frequency accuracy can be controlled to a staggering one part in four billion.

Low distortion was not a major design requirement, so for simplicity no measures were taken to improve this. The total harmonic distortion (THD) is around the 1% mark, which is adequate for most general applications. External output filtering can be added to improve this if desired.

IC3 is clocked by XTAL OSC1, an industry standard 50MHz TTL/CMOS 8-pin DIP crystal oscillator. The stability of the generated output signal will be dependant upon this clock but for this low-cost application any grade oscillator will suffice.

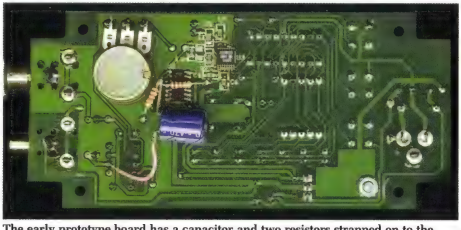
There are many brands of oscillator that match this standard footprint – some come in plastic DIP, while others come in a metal can package.

IC3 requires digital and analog power and ground pins. These are individually decoupled at the power pins and run as separate lines from the regulators.

IC3 provides a current output on pin 14, which is converted into a voltage by R4. C11 is an optional filter capacitor and is not fitted in the standard design. R2 sets the full scale DAC output signal current level, which in this case is approximately 3.9mA. This is already at a maximum value that will not compromise the performance of the chip.

Thus the output voltage across R4 will be approximately 1V p-p referenced above ground, as IC3 is powered from a single power rail. This signal is AC-coupled by C12 and referenced to ground and user adjusted by VR1.

The signal is then amplified by IC1 which operates with a gain of 4.9, as set by R5 and R6. This gives an approxi-



The early prototype board has a capacitor and two resistors strapped on to the back. In the final version these are "on top". The main purpose of this photograph is to show the components which are soldered to the back of the board, especially the tiny AD9835 TSSOP IC (top, centre) which requires great care.

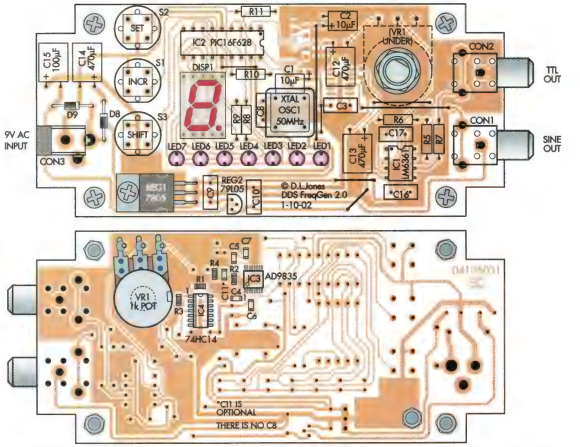


Fig.3: front (top) and back (bottom) sides of the PC board showing component placement. It is a single-sided board as far as tracks are concerned; some components are on the track (copper) side. The majority of components are polarised or need to be mounted a certain way (for example, the three pushbutton switches). Note carefully the comments about soldering IC3 (and IC4 for that matter).

mate maximum output signal level (at all frequencies) of ±2.5V peak. Thus the final sinewave output level is adjustable from 0-5V p-p.

IC1 provides a low impedance buffered output and R7 provides a nominal 50Ω output impedance. IC1 can be either a National Semiconductor LM6361 or an Elantec EL2044. The EL2044 is the recommended device as it has a slightly higher bandwidth, so will provide a higher signal level output at the high end of the frequency range.

IC4 is a hex Schmitt inverter, with C13, R1 and R3 providing a level shift function to bias the ground-referenced sinewave input signal to half the supply rail (suitable for a 5V TTL input). The Schmitt input squares up the sinewave and gives a CMOS/TTL output.

The 7-segment display and digital LEDs are multiplexed onto the same output pins on IC2. The common cathode line for both displays goes back to a separate pin on IC2. IC2 is thus able to "switch" alternately between displaying the 7-segment display and the digit LEDs. This is done in firmware and each display is turned on for a 5ms burst at a rate determined by the main loop. As long as it is greater than 50Hz or so you won't see any flicker – all the LEDs appear to be continuously on.

The pushbutton switches are debounced in the firmware by a small delay of a few hundred milliseconds after each key press.

The power supply is a typical half-wave rectified AC input with positive and negative 5V regulators (REG1 & REG2).

Heat dissipation in the regulators

Parts List – 10MHz DDS Function Generator

1 PC board, 123 x 56mm; coded 04105031
1 UB3 Jiffy box (130 x 67 x 44mm)
1 18-way IC socket (for IC2)
3 momentary action PC-mounting switches
2 RCA sockets, PC-mounting (with BNC adaptor if required)
1 knob to suit potentiometer shaft
4 12mm x 3mm tapped spacers
4 20mm x 3mm bolts, nuts and washers

Semiconductors
1 EL2044 or LM6361 opamp (IC1)
1 16F628 PIC microcontroller, programmed with DDSFRQ20.HEX (IC2)
1 AD9835 DDS generator (IC3)
1 74HC14 hex Schmitt trigger (IC4)
1 LM7805 +5V regulator (REG1)
1 LM79L05 -5V regulator (REG 2)
1 50MHz TTL oscillator (XTAL OSC1)
1 FND500 7-segment LED display (DISP1)
7 3mm red LEDs (LED1-7)
2 1N4001 silicon diodes (D1, D2)

Capacitors
2 470µF 10V PC electrolytic (C12,13)
1 470µF 25V PC electrolytic (C14)
1 100µF 25V PC electrolytic (C15)
2 10µF 10V PC electrolytic (C1,2)
2 100nF MKT SMD (0.2p) (C6,7)
5 100nF ceramic (C3,9,10,16,17)
2 10nF ceramic SMD (0.2p) (C4,5)

Resistors (1/4W 1% unless noted)
1 47Ω
1 120Ω
1 270Ω (SMD)
3 470Ω
2 1.5kΩ (SMD)
1 3.9kΩ (SMD)
2 470kΩ
1 1kΩ potentiometer

The PC board is connected to the case lid via four tapped spacers. Suitable cut-outs and holes in the lid allow the switches, LEDs and pot shaft to poke through, while the 7-segment display can also be seen through a cut-out.

will depend on the input voltage level from the plugpack. Ensure that this is not too high – a 9V AC plugpack is recommended as a maximum. The plugpack should be rated at 100mA or greater.

Parts availability

All of the components are available off-the-shelf for those who wish to construct the project from scratch. Farnell carry the "hard to get" bits like the AD9835, AD6361, 50MHz oscillator and surface mount 74HC14.

As far as the PC board is concerned, it is not out of reach of home manufacture using good lithography techniques, despite the TSSOP track/pad pitch being extremely small.

It is however recommended that a proper solder-masked PC board be obtained as this will make construction a lot easier.

The HEX file is available for download for non-commercial use from the SILICON CHIP website (**www.siliconchip.com.au**) and the author's website at **www.alternatezone.com**

Short form kits and PC boards may also be available from the author.

Given the popularity of the original design, it is probable that kits will be made available by major suppliers in due course.

Construction

Start construction with the AD9835 TSSOP IC (see separate panel). This way, there will be no other components to obstruct you and the board will sit flat and steady on your bench.

This IC is by far the most difficult component to solder in this kit; indeed, it may be the most difficult com-

Soldering the AD9835 TSSOP IC

Soldering the AD9835 is the most difficult aspect of project construction and unless you have the right tools and experience it is likely that you will have problems.

Don't underestimate how hard this will be: the pin pitch is 1/4 that of a regular IC and half that of a standard SOIC.

If you have a solder-masked PC board then your job will be a lot easier, as the solder mask will help stop the solder bridging between pins.

As a ***minimum*** you will need a good temperature-controlled soldering iron with a fine tip suitable for surface mount soldering, 0.45mm solder and tweezers. A chiselled tip is much better than a conical tip, which will have difficulty making good thermal contact.

The ideal tip to use is the "wicking" chisel type which has a small cavity in the middle of the tip to help "wick" the solder back off the joint, this helps to keep the amount of solder on the pins to an absolute minimum.

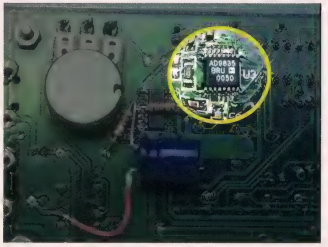
Proper 0.45mm surface-mount solder should be used – anything bigger will be a nightmare.

Alternatively (if you have them available), proper surface-mount solder paste and a hot-air surface-mount soldering gun will give you a first class job.

A magnifying lamp will come in very handy for this job – in fact, it is probably essential as many people will have to do the soldering under a magnifying lamp. You would need *really* good eyesight to solder and inspect the job without a magnifying lamp.

The best approach is to apply a small amount of solder to one of the corner pads of the chip. Then use tweezers to place the chip over the pad (ensure correct orientation!). You can then reheat this pin and move the chip with the tweezers to get it properly centred.

Before you solder any more pins, double check the orientation of the chip: desoldering the chip later is an option you don't even want to think about.



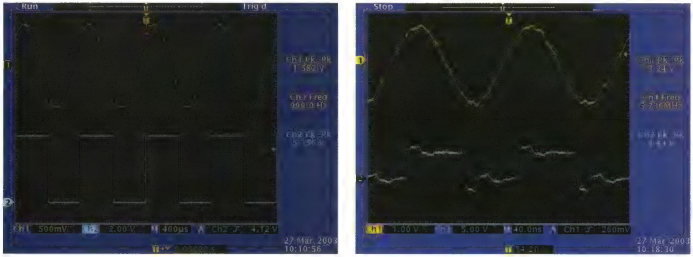
Once the chip is aligned on the pads correctly then solder the pin on the opposite corner so the chip will hold in place.

A "wicking" motion of the soldering iron away perpendicular from the pin is your best shot at avoiding bridges between pins.

The regular soldering technique of applying the iron to the pin and pad and then applying the solder on the other side of the joint will not work in this situation. Neither the soldering iron tip nor solder are small enough to allow this. You will find that excess solder will form around the joint no matter how hard you try to control how much you use. So you will have to just try and "wick" it away from the joint.

The biggest killer when hand soldering surface mount components is too much heat. Not only can excessive heat lift pads and crack tracks but worse, it can crack or destroy the component internally. Only solder one joint at a time and let the device cool before moving on. Do not apply heat to any joint for more than one or two seconds at most.

Patience here could help prevent a big headache later.



These two 'scope shots show both analog and digital outputs at two different frequencies. The shot on the left is at 1kH and shows a pretty good result on both sine and square waves. The other shot is at 5.736MHz (no, this frequency is nothing special!) and shows a still-quite-usable waveform in both cases. The ringing on the square wave, in particular, is due to the signal being unterminated – it would be significantly better into a load.

ponent you will ***ever*** have to solder!

Having successfully soldered and checked the TSSOP, the other 0805 passive components and the SOIC package will be much easier to solder – but similar rules apply. Watch the orientation of the SOIC.

Finish construction with the usual through-hole components. The PIC chip should be socketed to allow for firmware updates.

The 7-segment display will require a regular wide IC socket cut to size to stand it off from the PC board.

The LEDs should be mounted about 10mm proud of the PC board. The easiest way to do this and to ensure alignment of all the LEDs is to cut a 10mm strip of cardboard and place this between the legs of all the LEDs while soldering. Watch the LED polarity.

The PC board is mounted behind the front panel on four 12mm spacers

You may notice on the prototype that R1, R3, and C13 are retrofitted on the underside of the board. The published design has these components added to the top of the PC board, as shown on the overlay.

Testing

Before you power up the project, check for any shorts, especially on the surface-mount devices. Do a visual inspection and a multi-meter check. Don't try to probe the pins of the TSSOP chip directly; instead probe the other end of the appropriate track on a larger component.

Apply power to the project and ensure that the vital smoke is not escaping from any of the components! Next, measure the outputs of the regulators, they should be plus and minus 5V (respectively).

In use

When first powered up, the project will most likely be set to 0Hz, so there will be no output waveform. This could vary though, depending on the initial contents of the EEPROM bytes in the PIC chip.

In either case, press the SFT (SHIFT) button to select which digit will be displayed on the 7-segment display. Use of the SFT button allows you to quickly determine the output frequency.

The INC button will increment the currently displayed digit and will wrap back to zero. There is no ability to decrement the number other than the wrap around.

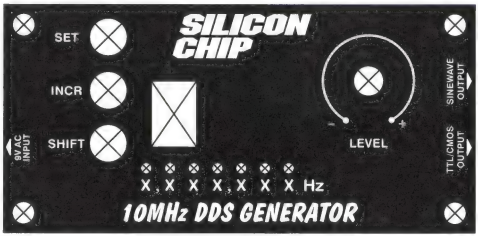
Using SFT and INC does not update the frequency at the output. To do this you must push the SET button. This sets the output frequency and also stores the frequency in the internal EEPROM memory, so this frequency will be automatically reloaded when the project is next powered up.

Remember that the output frequency will only change when you press the SET button, so the display will only reflect the actual output frequency when you have not touched the INC button since the last time the output frequency was set.

When using the TTL/CMOS output, ensure that the output level control is set to maximum, as this output is generated directly from the amplified sine -wave output.

Happy generating. **SC**

* david@alternatezone.com



Full-size artwork for the Function Generator front panel can also be photocopied and used as a drilling template for the case lid.

SERVICEMAN'S LOG

Fix the roof then fix the TV

Discovering a hole in the roof is never good news, especially if you don't know it's there until it rains. And if there's a fancy widescreen TV set sitting directly under the leak, it's more than the roof that will need fixing.

Mr Wilson (not his real name) is a barrister and lives in a beautiful harbourside mansion. Unfortunately for him, his mansion didn't have a perfect roof – something he didn't realise until, one evening, a bad storm forcibly brought it to his attention.

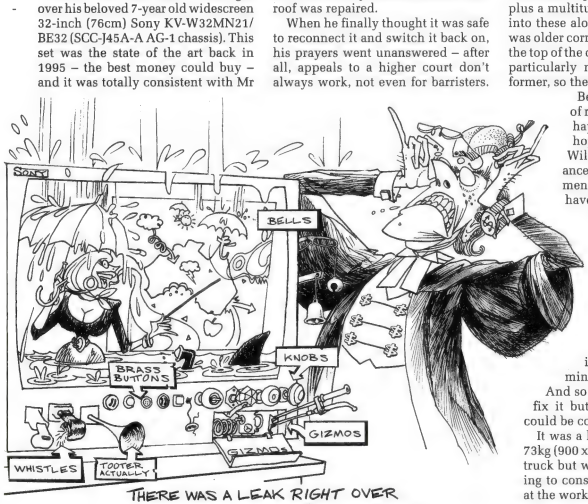
There was a leak and it was right over his beloved 7-year old widescreen 32-inch (76cm) Sony KV-W32MN21/BE32 (SCC-J45A-A AG-1 chassis). This set was the state of the art back in 1995 – the best money could buy – and it was totally consistent with Mr Wilson's "elevated" station in life.

When faced with this disaster, Mr Wilson moved as fast as he could to (a) switch the set off and (b) move it out of harm's way. But not knowing the extent of the water damage inside the "telly", he sensibly left it to dry out for a few days while the leak in the roof was repaired.

When he finally thought it was safe to reconnect it and switch it back on, his prayers went unanswered – after all, appeals to a higher court don't always work, not even for barristers. Apparently, there was a "phut" noise and a little "unmusical" electrical theatre before it all went silent. The only encore was a trickle of smoke and an unpleasant burning smell drifting up out of the ventilation holes at the rear.

Ever the optimist, he thought I could fix this in his home. Unfortunately, at that time, I didn't even have a circuit diagram. Still, I went through the motions of removing the back and inspecting the damage.

It was major – the water had leaked inside on a wide front from the deflection board (D) to the small signal and switchmode power supply board (A), plus a multitude of modules plugged into these along the way. Also, there was older corrosion from sea air along the top of the double-sided PC boards, particularly near the flyback transformer, so there was lots of damage.



THERE WAS A LEAK RIGHT OVER HIS "STATE OF THE ART" 76CM SONY...

Because of the likely cost of replacement parts, I was happy to declare the case hopeless and advised Mr Wilson to talk to his insurance assessors. To my amazement, it turned out he didn't have a policy to cover this.

Not only that but he insisted that he wanted it fixed – apparently it had "sentimental" value and it matched his minimalist (!) decor and the colour scheme in the room.

I found his reasoning unconvincing but mine is not to reason why. And so, reluctantly, I agreed to fix it but I warned him that it could be costly.

It was a huge struggle to lug the 73kg (900 x 600 x 584mm) set to my truck but we made it without having to consult a cardiologist. Back at the workshop, I had another tussle to get it onto the workshop bench

before I could finally tackle the destruction wrought by the water.

I started by dismantling the chassis, separating it into superficially damaged, severely corroded and damaged, and unaffected modules. It was soon clear that the power supply boards F1 and A were blown and that the deflection board was severely corroded and burnt.

I removed all the obviously burnt parts and then washed the boards to remove the corrosion. It was a long process, starting with scrubbing the boards with Nifti and then flushing with clean hot water. This was then followed by long periods of drying before using chemicals such as methylated spirits, CRC2-26, PC board cleaner and electrical cleaner to remove any residues and expel any remaining moisture.

I also had to "gouge" out areas where the board had deep ruts burnt into it. This process was tackled part time over a period of several weeks while the damage was diagnosed and parts ordered.

On the AC rectifier board (F1), R1602 (0.1Ω 0.5W) had vaporised and D1602 – a TF5415 power switching SCR – had gone short circuit. Naturally, the F3401 mains fuse (5AT) on board F2 had failed as well.

I wasn't sure about IC1601 (the STR81159A rectifier switch) but it looked OK so I left it for the time being. Later, I decided it was too risky not to replace it, as it might do more damage to the rest of the supplies, so I ordered a new one.

Next, I moved to the A board and took a closer look. The power supply occupies only a small part of this module (towards the front of the set) but it is packed with components on both sides, many being surface mounted. I measured both FETs Q605 & Q606 (IRF1840G-LF, CONV-OUT) as being short circuit and I also checked D601 (a protection diode) and zener diodes D605, D606 and MA8180M. To be on the safe side, I decided to replace them, along with IC601, IC602, IC651 and IC652, plus some of the surface-mounted transistors which didn't look too good from all the corrosion.

On the deflection board there was a nasty mess near plug CN515, which supplies high voltage to the CRT board (C). R540 (a 1.8kΩ feed resistor for the +1000V supply) and R546 (a 0.47Ω feed resistor for the +200V rail) were both burnt and were open circuit. The corresponding diodes were OK but the PC board was charred. The whole board had a lot of corrosion on top as well but nothing that wasn't linkable or fixable.

The required parts eventually arrived and I informed Mr Wilson of my estimate. It always amazes me how rich people can whinge so much about bills when no doubt mine would pale into insignificance compared to one of his. Nevertheless, when he got over the shock, he agreed to go ahead.

Chinese puzzle

I fitted all the parts and reassembled all the boards. This was a bit like a Chinese puzzle and CN101 was hard to find, being tucked up at the back behind all the plastic support brackets. The problem was that the plugs are unmarked and often the colour doesn't match the socket. In fact, you need the circuit to prevent plugging the wrong plugs into the wrong sockets.

Finally, I rechecked all my work, braced myself and switched it on.

The main thing was that there was no melt-down. Surprisingly, I had fixed the major parts of the power supply and the set was working after a fashion. I heard the EHT come up, the sound was good and I measured +135V on R3501 at the rear of the deflection board. However, I still had no picture.

It was hard to see the CRT filament heaters, so I measured them with a true RMS meter. I also measured the +1000V and +200V to the CRT board (C). I then momentarily shorted one of the tube cathodes to ground and got a flash of a fully scanned raster. But what was more interesting was that just by touching the cathode with almost anything restored the picture – and it was in colour!

The quality wasn't brilliant though and I began wondering whether the picture tube was suffering from low emission. When I switched the set off

and then on again, the picture disappeared but it could be restored by just touching anyone of the cathodes.

This was bizarre but seemed to be consistent with a low-emission picture tube affecting the RGB cut-off circuit via CN703-7 "IK OUT". This line should be at approximately 2.2V.

If the tube was flat, then increasing the heater filament voltage should also increase the beam current enough to overcome the cut-off circuit. I did this and also varied the voltage on the IK-OUT line but nothing made any difference.

Next, I removed the CRT board and examined it carefully. It was then that I noticed that it too had suffered from corrosion. I thoroughly cleaned it, replaced some of the transistors, particularly in the red and green amplifiers (Q703, Q709 and Q702, Q708), and thoroughly checked everything else. Nothing changed so I also replaced Q714 (spot suppressor) and zener diode D714 but again drew a blank.

So how could touching the cathode of any gun switch on the picture? Was I injecting a signal, was it the extra capacitance or was I somehow increasing the beam current? I was still sure it was the IK-OUT line and I hooked up the CRO on and checked the waveforms on it. Without a picture, there was no waveform and its DC voltage was just a fraction lower than normal. Conversely, when the picture was present, there were large line pulses.

It really didn't get me anywhere though and I concluded that I was

Items Covered This Month

- Sony KV-W32MN21/BE32 TV set (SCC-J45A-A AG-1 chassis).
- Panasonic NV-SJ400 VCR.
- Philips 29SP1698/75R TV set.
- Selectronics SPI 1200-SS 1200W inverter.

looking at the problem the wrong way.

Finally, I did what I should have done a lot sooner – I measured the voltage on every pin of the CRT, including the screen voltage to pin 3. This voltage was only at 225V whereas the circuit says the range should be 227-858V.

Having established that, I switched the set off and measured all the resistors around the screen control, including the control itself – all were correct. I then switched the set back on and ever mindful of how hard it is to align this control these days (see the service manual set-up adjustments), marked the position of the screen control knob. I then advanced it and as I did, the picture came up much better than before, with none of the colour bleeding that had previously been evident.

I experimented with a number of positions and finally settled for a voltage of around 430V, which gave the best picture.

So why didn't I follow the service manual's alignment instructions. The reason is that you have to: (1) set the picture to normal (define normal!); (2) set the video input to AV with no signal; (3) set the unit to Service Mode and turn off blue and black; (4) chase the BOF data of item number 1A (Auto Cut Off) from 00 to 01; (5) connect an oscilloscope to each of the cathodes and adjust (range 00-3F) 0E R-G, 0F G-G, 10 B-G Red, Green and Blue gain for a waveform that is 170V DC each above ground. And then it says "adjust G2 (RV701) volume to make the screen slightly bright".

Good, isn't it? You make all these careful accurate scientific adjustments to finally adjust it subjectively by eye! I skipped straight to the last line.

Anyway, this was finally all that was required to give it a crystal clear picture. I checked all its trick functions such as Text, Picture in Picture and 16:9, Dual Pictures, etc, etc and all were fine.

I quite liked the feature where you could have one half the picture of a TV channel and the other half on Teletext (Ch 7 Supertext).

Mr Wilson was as happy as a barrister can be with the set – but he didn't like the bill!

So what happened? I speculate that rain water had got into the G2 screen control RV701 and caused a high resistance contact between the wiper and the carbon track, enough to drop the voltage outside the beam current circuit's capture range. Unfortunately, I didn't have the luxury of being able to dissect the sealed control further to find out.

Home handyman

A young unmarried couple brought in a Panasonic NV-SJ400 VCR for repair. When asked what the fault was, they kind of shuffled nervously and looked at each other before coming up with "no picture".

I didn't pay too much attention to this display of body language, until she qualified the statement by confessing that "initially there was no picture but now there was a something loose inside and something might be a bit bent . . ."

Eventually, after a bit of gentle persuasion, the full story slowly came out.

They were watching an old tape and the picture went snowy. They figured out, probably correctly, that the tape had dirtied the heads and so had used a wet-type head cleaner. Apparently, this didn't work, so they tried it again. When this failed, the boyfriend decided to open it up and "have a look".

All that took place only about an hour or so before they brought it to me! This was going to be good so I decided to have a good look inside while they were both still there.

Inside, I found that the automatic head cleaner was at a crazy angle, with part of its lever jammed hard under the master cam. Worse still, the take-up arm was missing altogether – that is, until the boyfriend reached into his pocket and sheepishly handed it to me – "is this important?".

This was already looking close to terminal for such a basic VCR and the end finally arrived when I noticed that one of the video heads was hanging loose from the upper head drum.

In the end, I told the couple that they had to go and buy new one. And so they left, wildly making all sorts of allegations at each other. My guess is that they are no longer a couple and that they will remain unmarried for some time yet!

Philips TV set

The Philips G110S chassis had a long and successful career in Australia in the early 1990s and was subsequently superseded by the G111S and G112. However, I don't see too many of the G112S, as it is the backbone of the more upmarket models, with advanced options and accessories. However, from my perspective, the three chassis are close enough in similarity to be able to use the same methods when it comes to repairing them.

I had a Philips 29SP1698/75R dropped in the other day with the fault marked as "No Sound". In fact, when I got it onto the workshop bench, the fault was more accurately "dead". The front LED was flashing rapidly in yellow (red and green).

A quick look at the chassis revealed that someone had put a lot of work into changing all sorts of parts (you could tell by the soldering). This meant that I had to be on my toes and look out for unusual problems.

When I said that the set was dead, this wasn't quite strictly true. Initially, you could hear the EHT static build up and then the set would die. It was as though a protection circuit had come on.

I checked the main +140V supply rails and the 5V out of the SOPS (Self Oscillating Power Supply) and they were OK. However, based on my experience with the G110S, I mostly sus-

pected microprocessor IC7200 and the EEPROM (IC7278). As a result, I decided to replace them both with parts scrounged from a few scrapped chassis in my workshop.

The EEPROM was easy and I mounted it in an 8 pin socket for convenience. By contrast, the 42-pin high-density microprocessor was more recalcitrant but neither made any difference. The only real clue I had was the initial complaint of "No Sound".

I followed up on this lead and found that IC7266 (TDA8425) was short circuit on pin 4 – the +12V input. I also I found that R3277 – a 68Ω feed resistor – was open circuit, even though it looked brand new. Replacing both these parts brought the set back to life but only in a very limited way.

I could switch the set on with the remote control and the Green LED would stay on constantly. Additionally, there was a raster and there was hiss in the loudspeakers at high volume but apart from that, there was no sound or picture and no on-screen display.

Well, I searched high and low trying to find out what was going on. Eventually, some oscilloscope checks showed that signal was getting as far as the analog switching ICs on the AV module but no further. I then replaced the original EEPROM without result but was reluctant to replace the microprocessor because of the delicate work involved.

I still really couldn't comprehend why the set closed down when the sound output IC died. There are no protection circuit sensors in that part of the set – I can only conclude that the SDA and SCL data lines from pins 11 and 12 were feeding the information back to the microprocessor which closed it down.

By now, I was contemplating changing all the ICs on the AV module when I noticed that the microprocessor actually had G110S stamped on it. It was then that the penny dropped – I had used a microprocessor from a G110S chassis rather than the real McKoy and they were not interchangeable.

Replacing the original microprocessor finally fixed the problem completely.

Now here is a contribution from one of our readers. It comes from A. P. of Kuranda, Qld. This is how he tells it . . .

DC-AC inverter

This story concerns a Selectronics SPI 1200-SS 1200W inverter, circa 1992, owned by John and Maria who live in Cooktown in far north Queensland. Their main source of power is a micro-hydro system which charges a bank of deep-cycle batteries and they used the inverter mainly to run their washing machine.

This particular model of inverter produces a PWM square wave, so it isn't really suitable for inductive loads like washing machines. Because of this, I wasn't terribly surprised when John told me it had "blown up" the washing machine about two years ago. On that occasion, they had sent the inverter to Sydney to be modified so that it was more suited to the task, although just what had been done wasn't made clear. Since then, it had operated the washing machine without any problems until recently, when it blew the main fuse (about 100A) on the battery bank.

The first problem I encountered when I got the beast into the workshop was how to try it out safely. If it could blow 100A fuses (and the user manual claimed it would limit its current drain to 450A!), I didn't want to connect it straight across the 12V truck battery I planned to use for testing.

I ended up jury-rigging a single strand of 16A household fuse wire in the battery positive connection. I then gingerly connected the negative lead to the battery – there was a brief chirp from the undervoltage alarm, a satisfying click as the reverse polarity protection relays changed over, and the fuse stood its ground.

So far, so good. However, when I set the inverter to the demand-start override mode, there was a buzzing noise. It sounded like the circuitry was under strain and the fuse immediately vaporised.

Figuring that this thing might need a bit more than 16A just to start up, I tried it again with two strands of fuse wire. Again the fuse was vaporised at switch-on.

By now, I had proved to my satisfaction that there was a fault and that it seemed to be persistent. It was time to get serious, so I took the lid off.

Inside the case was a whopping transformer, over which was mounted a single large double-sided PC board (component side down). There was also a large heatsink on the back of the case for the main MOSFETs, plus a smaller heatsink mounted on the side of the transformer for the secondary-side "power-recovery" MOSFETs.

I pulled the PC board out and began

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looking for obvious problems. However, there was no obvious sign of why the thing was eating 100A fuses for breakfast.

The next things to test were the MOSFETs. This inverter uses a total of 26 BUK456-50A MOSFETs to drive the primary of the transformer. As well, there are six further MOSFETs, type BUK437-500B, in a "power-recovery" circuit on the secondary side of the transformer.

I wasn't surprised when all the primary-side MOSFETs checked out OK – if any had gone short circuit, the inverter would be drawing significant current even before the demand-start circuit was activated. Conversely, MOSFETs going open-circuit wouldn't blow the fuse, although this doesn't mean that none might not have done so.

A more likely cause of the problem, especially considering the inductive load provided by a washing machine, would be that one or more of the secondary side MOSFETs had gone short-circuit. These are all mounted, along with their 10Ω gate resistors, on a tiny strip of PC board nestled in a heatsink mounted on the side of the transformer. Some phenolic insulating material was riveted to the base of the heatsink, hiding the MOSFETs, so I drilled out the rivets and began testing.

Minor discovery

And here I made a minor discovery. All the MOSFETs and gate resistors were fine but one of the gate resistors had not been properly inserted and one of its leads was only just touching the solder that covered the hole it was meant to go through.

This was easily fixed but I could not imagine that this was the cause of the fuse-blowing. Indeed, a quick test showed that there was no change in the inverter's behaviour.

At this stage I suspected that the present problem lay in the circuitry controlling the MOSFETs. I considered verifying this by testing the outputs of the MOSFETs without the transformer connected but since there would now be no feedback from the secondary of the transformer, I wasn't sure that this would prove anything. In addition, even if I found a problem here, I'd still have to find the fault in the control circuitry.

The main PC board in this inverter is mostly populated by inexpensive, readily available parts, so in the absence of a circuit diagram which might make a deductive approach possible, I decided on a shotgun approach: check or replace everything on the board.

I started with the resistors. This approach bore fruit very quickly when I found that R50, a 68Ω 1W resistor, was open circuit. There was no obvious heat damage to the resistor and I expected that this was the fault. However, when I replaced it and re-tested the inverter, its behaviour was the same as before.

I then checked every transistor and diode, the leakage and ESR of every electrolytic capacitor and the breakdown voltage of every zener diode. This revealed nothing so I checked the trimpots. The current limit trimpot, P7, is marked 200Ω but measured nearly 300Ω. I replaced it but didn't imagine that this would fix the problem. I was right.

Next, I started on the ICs. I was able to verify that the timebase, an M706B1 with a 6.5536MHz crystal, was producing a 100Hz square wave. I also verified the operation of two 4N25 optocouplers which provide isolated feedback from the 240VAC output to the control circuitry.

The other ICs couldn't be tested so easily without a circuit diagram, so I replaced them. There were three CD4093s, an LT3524 PWM controller, an LM335 temperature reference and an NE555 timer. Because the fault was not intermittent, and because these are all inexpensive parts, I replaced them all at once without reassembling the thing each time to test it.

If that had fixed it, we still wouldn't know exactly where the fault was. Fortunately for this story, the fault was still there.

By now, there really wasn't anything left on the PC board to check. So could it be a component that wasn't mounted on the board? Surely that massive transformer couldn't have a shorted turn, could it?

It was easy to test: I connected the output of a 9VAC 1A plugpack to the primary of the transformer and measured the voltage on the secondary. It was only 1.25V AC and the plugpack was pumping out 1.5A. Voila! I phoned Selectronics and they verified that I ought to be getting a much higher output voltage, with an input current of only 150mA at no load.

In retrospect, I should have tested the transformer a lot earlier but I had considered it so unlikely to be faulty that I hadn't bothered.

At that point, I declared the inverter a write-off. The price of new inverters has plummeted recently and a new transformer would cost almost $400. And after all that, it would still be just a PWM inverter. I have therefore advised John and Maria to save their pennies for a sinewave inverter to run their washing machine.

This all happened about two years ago and I have since encountered quite a few faulty high-power transformers, mostly in amplifiers. The humid environment here in the tropics obviously doesn't do them any good. **SC**

Autumn Bargains

May 2003 ISSUE

Digital Voice Recorder with Digital Camera

NEW

With the incorporation of a camera, you can capture good quality images to compliment your recordings. The camera has a resolution of 300K pixels (640 x 480), and can store up to 255 images.Upload to PC via the USB cable, and manipulated with the software (both supplied). See cat pg 353 for details and specs.

Cat. XC-0284 $399

Kingcell AA Alkaline Batteries - Pkt 4

UNBELIEVABLE

These batteries were incorrectly stocked on our warehouse. Luckily for us we have found them as the 'best before' date is this August (2003). Luckily for you too, though. Grab 'em and use 'em before August and save over 60%!

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SB-2419	$1.50 pkt	$1.35 pkt

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CHEAP — Priced Way Way Below Normal, Limited Quantity, Stock up Now! — CHEAP

Cat.	Length	Pack Qty	1 Pkt	4 Pkts	10 Pkts	Cat 5e/ea
YN-8180	0.5m	5	$9.95	$8.75	$7.75	$3.25
YN-8181	1.0m	5	$11.95	$10.70	$9.50	$3.95
YN-8182	1.5m	5	$13.95	$12.35	$10.95	$4.50 approx
YN-8183	2m	2	$7.50	$6.75	$5.95	$5.25
YN-8184	3m	2	$8.95	$7.95	$6.95	$6.95
YN-8185	5m	2	$12.50	$10.95	$9.95	$8.95

High Capacity Ni-Mh Batteries

	Cat.	Qty 1+	Qty 10+
AA 2000mAh Nipple	SB-1706	$5.95	$5.25
AA 2000mAh Solder Tags	SB-1708	$6.25	$5.50
AAA 800mAh Nipple	SB-1720	$3.59	$3.15
AAA 800mAh Solder Tags	SB-1722	$3.78	$3.30

AA 1800mAh Pk 4 Nipple — Cat. SB-1712 $18.95 NEW

Gold Wafer Card

A multi-chip smart card based on the PIC16F84A and coupled with a 24LC16B EEPROM

Cat. ZZ-8800 1+ $19.95

10+ See Deal No. 1 on the right

NEW

Fun Wafer Card

An ATMEL based smart card with a AT90S8515A and coupled with a 24LC256 EEPROM.

Cat.	Qty 1+	Qty 10+	Qty 25+
ZZ-8806	$34.95	$31.45	$27.90

Silver Wafer Card

A multi-chip smart card based on the PIC16F877 and coupled with a 24LC64 EEPROM.

NEW

Cat.	Qty 1+	Qty 10+	Qty 25+
ZZ-8810	$29.95	$26.90	$23.70

Emerald Wafer Card

A multi-chip smart card based on the PIC16F628 and coupled with a 24LC64 EEPROM

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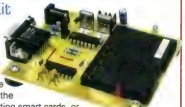

Ref: Silicon Chip January 2003
Compatible with most programming software available on the internet to suit this type of serial port device. Please note that a Phoenix type programmer will only program the EEPROM (eg 24LC16B) in existing smart cards, or blank cards with an EEPROM loader software present. It will not program the PIC or ATMEL within the card. Kit supplied with all electronic components. Requires 9-12VDC.

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Wall Clock with Thermometer Barometer/Hygrometer

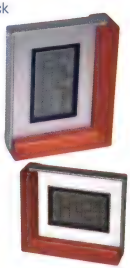
Keep an eye on the weather with this large round face wall clock that displays the time, temperature, air pressure and humidity. See Cat page 349 for other fantastic additions to our range.

NEW

Cat. XC-0320 $59.95

Matrix Alarm Clock

This clock can be mounted in portrait or landscape format and it knows which way to display information on its LCD screen. It features a daily alarm and backlit display at the touch of a button. Temperature can be in C/F and time can be expressed in 12/24 hours. See Cat page 347 for details.



NEW

Cat. XC-0140 $34.95

8 Language Pocket Translator

Translate to and from most widely spoken European languages. Conversion languages include: English, French, German, Spanish, Italian, Dutch, Portuguese and Turkish. Includes personal organiser features including calculator, currency converter, alarm and games.

NEW

Cat. XC-0180 $24.95

Hand Powered Dynamo Torch

NEW

Ever been caught in the dark with a torch but no batteries that work? This torch is great for those situations and more as it is hand powered. It has a small dynamo inside that powers the globe when you pump the handle. A torch that lasts forever, no batteries required!

Cat. ST-3335 $14.95

Stainless Steel Spanners with Ratchet Mechanism

NEW

Have the best of both worlds! Save time and frustration on those fiddly jobs. These ring spanners have an inbuilt ratchet mechanism to get into the places a regular ratchet can't. They are made from high quality stainless steel and will make a valuable addition to every toolbox.

10 / 11mm Spanner - 175mm long

Cat. TD-2140 $36.95

11 / 13mm Spanner - 205mm long

Cat. TD-2141 $39.95

Hand Held Body Fat Analyser with Clock

NEW

A compact and handy device for the health conscious to measure body fat content. The measurement is displayed on the LCD screen as a percentage with an indication for Slim, Normal, Overweight, Highly and Extremely overweight for the personal data entered.

Cat. QM-7252 $29.95

Keyring Data Bank

So small you'll forget it's on your keyring. It's a mini touchscreen PDA, with internal memory for up to 100 records; names, phone numbers and email addresses. Features include world time, currency conversion, multiple alarm clock, calculator, lock and auto power off. Measures only: 65(L) x 42(W) x 15(D)mm.

Cat. XC-0182 $19.95

NEW

Hot New Books!

NEW

Practical Robotics

Covers in detail the principles of robotics, and everything to get you started. It then moves into mathematical equations, recommended parts and even tools. 337pages.

Cat. BW-1380 $99

Electric Motors & Mechanical Devices

A great compliment to Practical Robotics, it covers the use of servo motors, speed control, and further detailed techniques for working with motors and mechanical devices. 237 pages.

Cat. BW-1382 $69.95

Automatic IR Remote Control Alarm Clock

Not your average alarm clock, this fantastic device will learn almost any command (eg. On/Off) from an Infra-Red remote control, and will operate that function at a specified time. Ideal for TV, video and airconditioning etc. See Cat page 347 for details.

NEW

Cat. AR-1732 $29.95

Infrared Remote Control Keyring

Measuring a tiny 60 x 33 x 15mm, this stylish infrared TV/VCR remote control allows you to operate the volume, channel and power functions of many TV's and VCR's. Preprogrammed for over 2250 devices.

NEW

Cat. AR-1730 $19.95

RESPONSE PRECISION Premium Audio Video Leads

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A premium range of interconnect cables for the proud audiophile or the passionate home theatre enthusiast. Designed in the USA for reliable, high quality connections between audio and video equipment. Featuring outstanding specifications and assembled to high standards for trouble free viewing or listening. A worthwhile investment. See cat pg 213 for details and individual specifications.

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2 x RCA to 2 x RCA Audio - 1.5m
Cat. WQ-7470 $69.95

3 x RCA to 3 x RCA Component - 1.8m
Cat. WQ-7475 $69.95

Audiophile Speaker Lead Pair - 2.5m
Cat. WQ-7485 $89.95

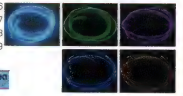
S-VHS to S-VHS Video - 1.5m
Cat. WQ-7480 $39.95

Personal EL Wirelight

Great for parties and nightclubs, these personal wirelights come in a range of colours. The handheld controller features on/off and strobe functions.
See cat pg 337 for details.

NEW

Aqua	Cat. SL-2845
Lime	Cat. SL-2846
Red	Cat. SL-2847
Blue	Cat. SL-2848
Orange	Cat. SL-2849



ALL COLOURS $24.95 ea

Smart Solar Battery Charger

In sunlight, this unit supplies 15V at around 100-120mA, enough to keep an infrequently used 12V battery topped up and ready for use.

NEW

Cat. MB-3501 $49.95

Ceramic Heater 12V

NEW

This 12 Volt Heater has 2 heat settings, 150W and 250W, and it can be used simply as a fan, if heating is not required. It has a cigarette lighter plug for power, but we suggest you check if your cigarette lighter socket will handle the high current draw.
Size 175(W) x 140(H) x 115(D) mm excluding mounting bracket.

Cat. YS-2805 $39.95

Multifunction Pedometer (Step Counter)

NEW

It is small, and clips on your belt. It includes a calorie counter to help you gauge the effectiveness of your exercise. Also features a clock, alarm and stopwatch.

Cat. XC-0262 $19.95

Reversing/Parking Sensor with Audible Indicator and Flush Mount Sensors

Unlike our previous models, this unit uses discreet flush mount sensors. The pack is even supplied with a hole cutting drill bit for easy installation into most plastic or fibreglass bumpers.
See cat pg 169 for details and specs.

NEW

Cat. LR-8868 $99.95

Portable Stove 12V

This unique 12V stove is ideal for cooking and/or keeping food hot on those long trips. It has a maximum temperature of 140°C, and insulation keeps the outside cool. See cat pg 358 for details.

NEW

Cat. YS-2808 $49.95

Wireless Doorbell with Clock & In/Outdoor Thermometer

Not your average doorbell. This unit offers standard doorbell functions, though the receiver also houses a large LCD clock with date, and an in/outdoor thermometer. See cat pg 347 for details.

NEW

Cat. XC-0250 $54.95

Personal Fan with Storage Compartment

By the pool, in the car or relaxing under a tree, you can use this handy little fan to cool down. It has soft blades for safety and a storage compartment to keep your valuables.

NEW

Cat. YX-2590 $9.95

Digital Wrist Watch with Pulse and Temperature

As well as a standard digital watch, it features date, alarm, stopwatch, and gives the temperature and pulse of the wearer. Simple to use, it is an excellent fitness aid.

NEW

Cat. XC-0260 $19.95

Clear Fan with LED's - 80mm 12VDC

NEW

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See cat pg 55 for details.

Cat. XC-5059 $19.95

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Low Cost 4 Channel Colour Video Switcher

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Cat. QC-3370 $49.95

NEW

Quad Processor B&W with Motion Detection and Audio

This 4 channel quad processor features the option of a 4-way split screen, or switching display. If features an optional motion detection function, and switches instantly to the camera detecting movement (with use of PIR).
Also features 'picture in picture' capabilities, and a time/date displayed on the monitor.

NEW

Cat. QC-3372 $179.95

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B&W CMOS Pinhole
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Cat. QC-3473

Colour CCD Pin hole with Sony Sensor & Audio
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COLOUR
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Cat. QC-3496

B&W CCD Waterproof
Was $209 Save $20
Now $189
Cat. QC-3490

Colour CCD Waterproof
Was $369 Save $40
COLOUR
Now $329
Cat. QC-3492

B&W CCD Dome
Was $109 Save $10
Now $99
Cat. QC-3472

Colour CCD Dome with Sony Sensor
Was $239 Save $30
COLOUR
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Cat. QC-3489

B&W CCD Bullet Style
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Backlit DMM
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LIMITED QUANTITY
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Cat. QH-1320

Probe Style DMM
Was $29.95 Save $5
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Cat. QH-1497

AC/DC Current Clamp Meter
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Now $139
Cat. QH-1562

Animated Singing Birds

This delightful product consists of two birds (about finch-size) perched on a plastic but realistic looking piece of branch. The branch conceals a Light Depend Resistor (LDR). When a person walks past the birds burst into song. Not only do they twitter away to each other, their beaks move as well as their tails. Requires 3 x AAA cells not included.

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Colour Full Duplex Multiplexer - 16 Channel

- 16 camera inputs
- 6 digit name assignment
- 7 different display modes
- Alarm signal inputs

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Cat. QC-3366 $1,195

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B&W CMOS camera with IR
- 4" LCD monitor
- Electronic door strike control
- Expandable up to 3 monitors

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Cat. QC-3413 $229

Extra Receiver Cat. QC-3415
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4 Channel Colour Full Quad Processor

- 4 channel quad or switching display
- RS-232 interface
- PAL and NTSC support
- Dual video outputs for monitoring and recording
- Auto bypass of unused inputs

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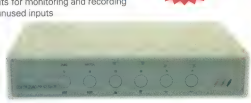

Cat. QC-3363 $349

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Cat.	Description	Was	Now	Save
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AA2019	Headset Microphone/Headphones	$22.95	$14.95	$8.00
AA2026	Earphone/Microphone on Small Boom	$27.00	$13.00	$14.00
AM4086	Karaoke Microphone	$46.95	$28.95	$18.00
AR1701	Preprogrammed TV/Video Remote	$24.95	$16.95	$8.00
AR1715	Tabletop Universal LCD Remote	$399.00	$299.00	$100.00
AS3181	Rectangular Communications Speaker	$16.50	$8.50	$8.00
AX3517	6.5" Speaker - Pair	$7.95	$4.95	$3.00
AX3654	Sound Absorbing Acoustic Tile	$12.95	$6.95	$6.00
AX3690	350gsm Speaker Damping Material	$7.75	$5.75	$2.00
BA1402	Loudspeaker Recipes Book 1	$49.95	$26.95	$23.00
BA1430	Sound Studio Construction on a Budget Book	$72.95	$49.95	$23.00
BA5040	Natsemi Audio/Radio Handbook	$39.95	$24.95	$15.00
BB7009	45 Simple Electronic Terminal Block Projects Book	$19.95	$13.95	$6.00
BB7447	Troubleshooting PC Printers Book	$27.95	$19.95	$8.00
BF4170	Hums & Buzzes Explained Book	$7.95	$4.95	$3.00
BM2481	Guide to PIC Microcontrollers Book	$34.95	$24.95	$10.00
BM4580	World Semiconductor Equivalents Book Vol 1	$39.95	$24.95	$15.00
BM4582	World Semiconductor Equivalents Book Vol 2	$39.95	$24.95	$15.00
CS2532	10" Knockdown Subwoofer Enclosure	$109.00	$79.00	$30.00
CS2534	12" Knockdown Subwoofer Enclosure	$109.00	$79.00	$30.00
CS2538	12" Sealed Knockdown Subwoofer Enclosure	$99.00	$74.00	$25.00
CS2586	JC25 Speaker Cabinets - Pair	$199.00	$169.00	$30.00
CT1928	KSN1188 Piezo Compression Driver	$125.00	$85.00	$40.00
CT1956	KSN1196A Exponential Horn	$85.00	$60.00	$25.00
CW2046	6.5" Carbon Fibre Woofer & Chrn	$78.95	$45.95	$33.00
CW2947	Silver Speaker Stands - 400mm High - Pair	$99.00	$69.00	$30.00
CW2949	Silver Speaker Stands - 900mm High - Pair	$139.00	$99.00	$40.00
CX2619	3 Way 80W Speaker Crossover	$26.95	$16.95	$10.00
HB5555	Professional Bench Enclosure	$50.95	$37.95	$13.00
HB6364	Foam Insert ABS Carry Case	$69.95	$49.95	$20.00
HC4054	Platinum Battery Terminal - 4 Wire '+'	$32.95	$19.95	$13.00
HC4056	Platinum Battery Terminal - 4 Wire '-'	$32.95	$19.95	$13.00
HC4057	Clear Protective Cover Suit HC4054,HC4056	$6.95	$3.95	$3.00
HC4061	Gold Battery Terminal - 3 Wire '+'	$21.95	$11.95	$10.00
HC4063	Gold Battery Terminal - 3 Wire '-'	$21.95	$11.95	$10.00
HM3188	Fused Terminal Block - 3 Way	$4.20	$3.20	$1.00
HM3838	Plastic Cabinet Corners Pk8	$11.75	$5.75	$6.00
HM3846	Chrome Cabinet Corners Pk 8	$15.00	$10.00	$5.00
HP0712	6-10mm Adjustable Waterproof Grommet Pk2	$4.25	$2.25	$2.00
HP0804	Push on Rubber Feet Pk4	$1.40	$0.80	$0.60
HM3006	30Amp Battery Clips Pk2 Black & Red	$2.75	$1.25	$1.50
HS9009	Steel Cabinet Handle	$8.95	$4.95	$4.00
KA1817	PC Auto Powerup Kit	$34.95	$21.95	$13.00
KC5316	4 Channel CCTV Switcher Kit	$89.95	$59.95	$30.00
KC5328	Itsy Bitsy USB Light Kit	$12.95	$7.95	$5.00
KD6014	555 Timer Kit	$24.95	$14.95	$10.00
KD6016	Simple Timer Kit	$19.95	$14.95	$5.00
KD6017	Micro Multimode Timer Kit	$42.95	$29.95	$13.00
KD6022	9V FM Transmitter Kit	$17.95	$10.95	$7.00
KD6024	3 Stage FM Transmitter Kit	$19.95	$12.95	$7.00
KD6050	10W x 2 Stereo Amplifier Kit	$33.50	$23.50	$10.00
KD6056	Simple Preamplifier Kit	$13.95	$8.95	$5.00
KD6058	4 Digit Down Counter Kit	$36.95	$24.95	$12.00
KD6062	Serial PIC Programmer Kit	$42.50	$25.00	$17.50
KD6064	16F/C84 PIC Programmer Kit	$69.95	$49.95	$20.00
KD6081	40 Sec Voice Recorder Kit	$39.95	$27.95	$12.00
KD6084	4 Digit Up/Down Counter Kit	$39.95	$24.95	$15.00
KE4730	Solar Cell Voltage Regulator Kit	$16.75	$10.75	$6.00
KG9022	Tone Generator Kit	$12.95	$7.95	$5.00
KG9144	Mini IR Light Barrier Kit	$7.95	$4.95	$3.00
KG9192	Test Signal Generator Kit	$6.95	$4.95	$2.00
KW3576	Infra Red Detector Kit	$24.95	$14.95	$10.00
KW3580	Light Beam Object Detector Kit	$22.50	$14.50	$8.00
LA5020	Pulse PIR - Analogue	$39.95	$24.95	$15.00
LA5021	Long Range Lens for Pulse PIR	$5.60	$2.95	$2.65
LA5023	Pet Alley Lens for Pulse PIR	$5.60	$2.95	$2.65
LA5190	PIR Motion Detector with Alarm	$59.95	$34.95	$25.00
LA5850	3 Output Digital Access Keypad	$129.50	$79.50	$50.00
LA5354	Remote Keyswitch Pad	$39.95	$24.95	$15.00
LA8920	Car Guard Engine Immobiliser with Remote	$59.95	$39.95	$20.00
LR8828	Pendant/Key Ring Emergency Transmitter	$54.95	$39.95	$15.00
LT3013	VHF-Lo/Hi/UHF Triplexer	$7.50	$3.95	$3.55

Cat.	Description	Was	Now	Save
MP3004	10VDC 850mA Plugpack	$14.95	$4.95	$10.00
NA1027	Water Displacement Aerosol	$8.95	$5.95	$3.00
PA3575	Taslink 2 Way Optical Splitter	$16.75	$9.75	$7.00
PP2004	Illuminated Cigarette Lighter Plug	$2.95	$1.95	$1.00
PS0653	1 x BNC Socket Wallplate	$4.00	$3.00	$1.00
PS0697	Mini UHF Socket RG58U Crimp	$3.80	$1.80	$2.00
PS0698	Mini UHF Socket RG59 Crimp	$3.80	$1.80	$2.00
PT4532	3.2mm Red Mini Spade Connectors Pk 20	$2.50	$1.50	$1.00
QC3200	4Ch Pan Tilt Controller	$149.00	$114.00	$35.00
QC3202	Pan Tilt Scanner Controller	$69.00	$54.00	$15.00
QC3206	Panning Camera Base	$129.00	$109.00	$20.00
QC3215	Pan Tilt B&W Speed Dome Camera with Audio	$499.00	$399.00	$100.00
QC3311	Colour CCD Camera with Auto Iris Control & Audio	$279.00	$179.00	$100.00
QC3462	2.4GHz Wireless Camera & Monitor	$329.00	$229.00	$100.00
QC3464	Colour CCD Dome Camera	$239.00	$149.00	$90.00
QM1321	Backlit DMM with Temp/Cap/Freq & Data Hold	$65.00	$39.00	$26.00
QM3400	2 Ch Switching 6" B&W Monitor	$129.50	$79.50	$50.00
QM3524	Floorstanding Magnifier Lamp	$139.00	$99.00	$40.00
QM7248	Mini 100g Scale	$149.00	$109.00	$40.00
QM7260	Digital Hand-Held Compass	$79.95	$49.95	$30.00
QP2250	DMM Multifunction Test Probe	$9.95	$6.95	$3.00
QV3052	4 Channel Digital Video Recorder	$2995.00	$2,295.00	$700.00
QV3055	4 Input Video Capture Card	$849.00	$549.00	$300.00
SB2455	AA Ni-Mh 1000mAh Nipple Cap Battery	$3.35	$1.95	$1.40
SB2463	Sanyo Sub-C Ni-Cad 600mAh Solder Tags	$8.95	$5.95	$3.00
SJ2948	Millenium Light Chaser with Remote	$129.00	$89.00	$40.00
SL2992	6 Colour Mini Linklamp Set	$49.95	$34.95	$15.00
SL2994	Green Lamp for SL2992	$3.95	$2.25	$1.70
SL2996	Yellow Lamp for SL2992	$3.95	$2.25	$1.70
SL2997	Orange Lamp for SL2992	$3.95	$2.25	$1.70
SL2998	Purple Lamp for SL2992	$3.95	$2.25	$1.70
SM1037	Switch - Ultra Mini Red	$1.70	$1.00	$0.70
SS0500	Bargain Switch Pack	$10.00	$6.00	$4.00
SS0830	PCB Mount DPDT Slide Switch	$2.50	$0.95	$0.30
ST0510	Switch - DPDT Centre Off Mom & Lock	$3.75	$2.50	$1.25
ST0512	Mini Toggle Switch DPDT Mom. Centre Off	$3.75	$2.75	$1.00
ST0542	Mini Toggle Switch DPDT	$2.50	$1.50	$1.00
ST0552	Economy Mini Toggle Switch DPDT	$2.90	$1.50	$1.40
ST0564	PCB Mount SPDT Toggle Switch	$1.20	$0.50	$0.70
ST3028	Torch/Strobe Light	$36.95	$24.95	$12.00
ST3054	Water Resistant Aluminium Hand Torch	$15.95	$9.45	$6.50
ST3062	2 x 20W 12VDC Fluorescent	$79.95	$49.95	$30.00
ST3093	Red LED Illuminated Whistle	$7.95	$4.95	$3.00
ST3094	Green LED Illuminated Whistle	$7.95	$4.95	$3.00
ST4090	Relay 24V SPST 8A@250VAC Contacts	$3.50	$2.00	$1.50
ST4055	Relay 110VDC SPST 8A@250VAC Contacts	$3.95	$2.95	$1.95
SZ2080	8 Gauge Inline Platinum Blade Fuse Holder	$17.95	$9.95	$8.00
TD2475	Cordless Mini Drill/Grinder/Engraver	$24.95	$16.95	$8.00
TH1756	High Quality Electrical Shears with Pouch	$24.95	$17.95	$7.00
TH1964	Screwdriver Carry Rack	$7.95	$4.95	$3.00
WB1742	2 Way Flat Self Adhesive OFC Speaker Cable	$2.95/m	$1.50/m	$1.45/m
WB1744	4 Way Flat Self Adhesive OFC Speaker Cable	$4.95/m	$2.50/m	$2.45/m
WV7424	N64 Controller Extension Cable 1.8m	$6.75	$4.50	$2.25
XC0123	Time/Date/Day LCD Module	$17.95	$9.95	$8.00
XC0124	LCD Countdown Timer/Controller	$19.95	$8.95	$11.00
XC0125	LCD Project Countdown Timer	$14.95	$7.95	$7.00
XC0280	Samsung 810mm Digital Voice Recorder	$419.00	$329.00	$90.00
XC4460	Serial PIC Programmer - Built	$89.95	$39.95	$50.00
XC4635	ATX Mini Tower Case with PSU	$79.50	$59.50	$20.00
XC4762	IOMEGA 250MB ZIP Disk	$33.95	$25.95	$8.00
YN8060	PCI Combo Ethernet Card	$27.95	$22.95	$5.00

Need to rewire your caravan, trailer or boat?

PA2060	7 Pin Flat to 6 Pin Round Trailer Socket Adaptor	$24.95	$12.95	$12.00
PP2050	7 Pin Flat Trailer Plug	$9.95	$5.95	$4.00
PP2054	7 Pin Round Trailer Plug	$8.95	$5.50	$3.45
PS2052	7 Pin Flat Trailer Socket	$10.95	$6.95	$4.00
PS2056	7 Pin Round Trailer Socket	$14.95	$8.95	$6.00
WH3090	7 Core Trailer Cable 10m	$24.95	$16.95	$8.00

Not all items available in all stores. Before driving across town, please phone to check that these products are available in your store. If not in stock in your closest store they probably won't be able to order it in for you.

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Jaycar ELECTRONICS

NEW

ADSL Line Filter

Conventional telephone equipment including telephones, modems, faxes etc., can share the same line as an ADSL connection. An ADSL line filter is commonly needed to prevent interference between the ADSL signal and telephone equipment and vice-versa. Full instructions supplied.

Cat. YT-6092 $19.50

Digital Non-Contact Thermometer with Laser Sighting - Improved Model

NEW

Measuring the surface temperature of an object was only generally possible by attaching a suitable sensor to it. There is now a quick and easy way to do all of the above - just point, pull the trigger, and read the display! Features include a large, green backlit LCD readout, data hold & auto power off, C/F degrees switchable and a comfortable, lightweight, design.

- Temperature range: -50 to +500°C / -58 to +932°F

New larger temperature range

Cat. QM-7222 $159.50

Extra Large Digit DMM

This full function meter features huge 38mm high digits with a backlight for easy observation in all conditions. It has a durable rubber surround to help prevent damage. It is a full featured meter with a high current range up to 20A. Also features frequency measurement and reverse polarity indication. Includes temperature probe See Cat page 235 for full details and specs.

- Capacitance
- Frequency
- Temperature
- Back Light
- Continuity Tester
- Diode Test
- Rubber Surround
- Data Hold
- 20 Amp
- Cat III 600V

NEW

Cat. QM-1450 $79.95

Autoranging RS-232 Digital Multimeter

NEW

Large 30mm high digit display which not only shows the reading, but also selected function and range, ambient temperature, various warnings and if the probes are incorrectly connected. It features an RS-232 connection, and the software supports a fixed sample rate of 1 per second, with adjustable scale real time graphical display.

Includes Temperature Probe & RS232 Cable

See Cat Pg 236 for full details.

- Backlit LCD
- Duty Cycle
- Frequency
- Dual Temperature
- Capacitance
- Continuity Buzzer
- 4000 Count
- Diode Test
- Holster Included
- Cat III 1000V

Cat. QM-1460 $169.95

DIGITECH

2" Widerange Speaker

This is an excellent little wide range driver with a large magnet and 8 ohm impedance. Size 53x53x30mm deep.

NEW

Cat. AS-3020 $3.95

vifa D26 Screened Tweeter

Features a compact design and a neodymium magnet. It has a coated fabric diaphragm, linear response, and is ferrofluid cooled. See cat pg 290 for details.

NEW

Cat. CT-2022 $39.95

vifa 5" Screened Midrange/Woofer

NEW

A magnetically screened unit featuring a light and rigid polymer basket and a mineral polypropylene cone. 8 ohm impedance and rated at 30WRMS (100W peak). See cat pg 290 for details.

Cat. CW-2100 $49.95

Multimedia Speakers with Subwoofer Set

NEW

For superior multimedia sound, use these desktop speakers with mini subwoofer in your home or office. They are mains powered, and are supplied with a 1.5m cable for PC connection. See cat pg 229 for details.

Cat. XC-5166 $29.95

High Quality 4 Speaker Multimedia System with Subwoofer

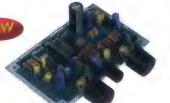
NEW

This system has a pair of 2-way speakers that can swivel allowing the tweeter and woofer to be independently positioned for optimum sound. These speakers are complimented by a 4" sub, and 40WRMS total system power. See cat pg 229 for details.

Cat. XC-5168 $79.95

Surround Sound Experimenters Module

NEW



This module enables you to connect a set of 'rear' speakers from a stereo signal and also provide a low pass signal for a subwoofer. It is not Dolby, nor does it delay the rear signal, but it does work surprisingly well. Requires 9 – 12VDC.

Cat. AA-0360 $24.95

How Embarrasing - 6.5" Kevlar Woofer

These drivers were part of our 6.5" Kevlar split speaker pack when they were first introduced. The factory unknowingly used the wrong glue on the rubber surround. In some cases after heavy use, the surround started to lift. If you have suitable glue, the rest of the driver is fine. We have replaced all the drivers in the packs, but have all these drivers left. 4Ω impedance, rated at 80watts max (50WRMS).

Were worth at least twice this much!

Cat. CS-2299 $20.00

NEW 388 PAGE CATALOGUE OUT NOW

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Rechargeable Super Drill Set with 56pc Accessories

This high torque drill is supplied in a plastic case, which will hold the drill, power supply, and all accessories. It is great for drilling, polishing, engraving, grinding, sanding and cutting. Features a fast change collet chuck system for ease of use.
See cat pg 280 for details.

NEW

Cat. TD-2462 $44.95

Vacuum Suction Pump

NEW

Utilising the same idea as a traditional plunger, only making the job easier.
See cat pg 280 for details.

Cat. TH-1972 $4.95

Deluxe Desoldering Tool

Japanese Made goot

Features Japanese build quality and a large vacuum chamber for extremely strong suction.

Cat. TH-1856 $24.95

NEW

Jaycar ELECTRONICS No 1 For Kits

AV Booster/Repeater Amp Kit

Ref: Silicon Chip April 2003

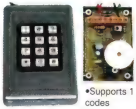
- Boost AV signal for longer cable runs.
- AV or S-Video Inputs/Outputs
- Kit includes case, silk screened and punched panels, PCB and all electronic components

Cat. KC-5350 $119.95

NEW KIT

Flexible Keypad Alarm Kit

Ref: Silicon Chip April 2003



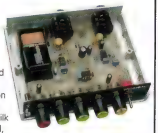
NEW KIT

- Supports 1 - 12 digit codes
- Instant and delayed inputs
- Electronic door strike control
- Kit includes PCB and all electronic components. • Case not supplied.

Cat. KC-5352 $39.95

Guitar Overdrive/Distortion Kit

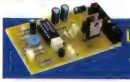
Ref Silicon Chip May 2003



NEW KIT

- Adjustable level and tone controls
- Adjustable distortion and a bypass switch
- Kit includes case, silk screened front panel, PCB and all electronic components.
- Battery not supplied.

Cat. KC-5353 $59.95



LOOKING FOR AN OLD KIT?

If you are, we may have it in our Kit Back Catalogue. The 'Kit Back Catalogue' range is listed on the Jaycar website (under Kits & Projects) and can only be purchased via the website "www.jaycar.com.au" or Techstore (i.e. not the Jaycar stores).

Telephone Dialler for Burglar Alarms Kit

NEW KIT

Refer SC April 2003

- Dial a preprogrammed phone number via modem
- Can be triggered by N/C or N/O contacts
- Easily programmed via PC
- Primary and secondary telephone number storage

Cat. KC-5348 $65

Low Cost Simple Hearing Aid Kit

Helps to assists hearing by amplifying room sounds etc. that are not easily audible. PCB and electronic components supplied.

NEW KIT

Cat. KF-4020 $18.95

Low Cost In-Circuit Transistor Tester Kit

Gives you a quick 'Go' or 'No Go' assessment of the state of PNP or NPN bipolar transistors without the need to desolder!
PCB and electronic components supplied.

NEW KIT

Cat. KF-4000 $9.95

'Quizmaster' Contestant Selector Kit

Determines which of the three buttons are pushed first. Just like in game shows! Uses red, yellow and green LED's as indicators.
PCB and electronic components supplied.

NEW KIT

Cat. KF-4030 $7.95

Low Voltage Alarm Kit

NEW KIT

Sounds a buzzer when the monitored voltage falls below a certain level. Great for campers using car batteries for appliances etc. PCB and electronic components supplied.

Cat. KF-4010 $13.95

Electronic Roulette Wheel Kit

Generates a genuinely random selection of one number in 36. It can also be configured to run continuously as a light chaser. PCB and electronic components supplied.

NEW KIT

Cat. KF-4040 $44.95

OVER 5,000 PRODUCTS IN STORE JAYCAR ELECTRONICS

M3 and M4 Metric Taps

NEW

Cuts standard M3 and M4 metric threads. Clean up a cross threaded nut or cut into a chassis or heatsink etc. High quality tool steel.

3mm
Cat. TD-2440 $2.95

4mm
Cat. TD-2442 $3.45

U-clip and Screw Assortment - 170pc

An assortment of u-clips and screws for a quick and easy way to secure wires, cables and objects to panels etc. Supplied in a handy plastic case.

Cat. HP-0640 $14.95

NEW

Heavy Duty F59 Connectors

As used by TV and Cable installers. Heavy gauge with a passivated finish.

For RG59 cable
Cat. PP-0702 $1.10

For RG6 cable Foxtel Approved
Cat. PP-0704 $1.10

NEW

Reducer 20A 24-12V

Features fan cooling, up to 90% efficiency and a compact, lightweight design. See cat pg 164 for details.

Cat. HP-3068 $119.95

NEW

Mini Bull Nose Pliers 4.5"

Made from hardened carbon steel with a micro-nickel finish. TUV and GS approved. A great addition to any toolbox.

NEW

Cat. TH-1889 $9.95

Audio Power Amplifier IC modules

Building a medium power audio amplifier has seldom been so easy. These modules contain all of the amplifiers electronics and require only a simple power supply to get them up and running. See cat pg 108 for details.

20W Cat. ZL-3760 $14.95

50W Cat. ZL-3762 $19.95

70W Cat. ZL-3764 $23.95

NEW

Soldering Iron - 13W 240V

•Japanese made
WAS $59.95 SAVE $10

goot

Cat. TS-1446 $49.95

Soldering Iron 46W 240V

•Japanese made
WAS $69.95 SAVE $15

goot

Cat. TS-1430 $54.95

Twin Fluoro Light 16W 12VDC

Uses 2 X 8 watt fluoro tubes, light output roughly equivalent to a standard 60 watt globe.

WAS $29.95 SAVE $7

Cat. ST-3020 $22.95

All prices valid to end May 2003

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Jaycar ELECTRONICS

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Reply Paid 6424, Jaycar Techstore Mail Orders, PO Box 6424 Silverwater NSW 1811
Free Call For Orders: 1800 022 888 Enquiries: (02) 9741 8538 Fax: (02) 9741 8559

EMAIL ORDERS: techstore@jaycar.com.au

Post $10 to $24.99:	$4.40	Road Freight Anywhere In Australia (up to 20kg):	$15.50
Post $25 to $49.99:	$5.50	Express Post Max.500g:	$7.70
Post $50 to $99.99:	$7.70	Express Post Max.3kg:	$11.00
Post Over $100:	$8.80		

*Overnight Delivery Available Subject to conditions:
•Max weight 3KG (inc cubic) $11 •No dangerous goods
•Max weight 5kg (inc cubic) $16.60 •Stock & availability
•Orders must be received before Midday E.S.T.

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•Unit 1/217 The Entrance Rd •Ph: (02) 4365 3433
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•Ph: (03) 6231 5877

SA - ADELAIDE
•191-195 Wright Street •Ph: (08) 8231 7355
VIC - COBURG
•266 Sydney Rd •Ph: (03) 9384 1811
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•Shop 2,45 A'Beckett St •Ph: (03) 9663 2030
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•2474 Gold Coast Hwy. •Ph: (07) 5526 6722
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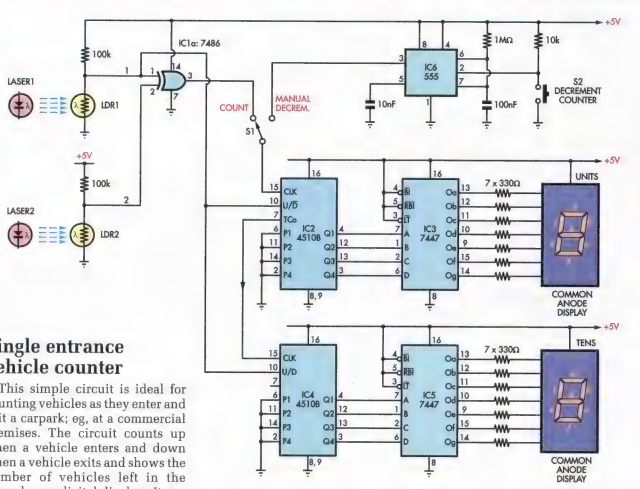
CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Single entrance vehicle counter

This simple circuit is ideal for counting vehicles as they enter and exit a carpark; eg, at a commercial premises. The circuit counts up when a vehicle enters and down when a vehicle exits and shows the number of vehicles left in the carpark on a digital display. It can count up to 99 vehicles but this could be extended by cascading additional counters.

The sensing circuit consists of two laser sources plus their associated light dependent resistors (LDRs). Normally, light from the two lasers shines on the LDRs which means that the resistance of the LDRs is low (ie, a few hundred ohms). As a result, the output of XOR gate IC1a is low.

However, when a laser beam is "cut" by the moving vehicle, the resistance of its associated LDR changes to several megohms. This in turn places a high on the corresponding input of IC1a and so IC1a's output at pin 3 also goes high. This high lasts for about 2s – ie, the time it takes for the vehicle to pass.

This output is then transmitted through a low-cost data cable to the counter section.

In practice, the two sensors are set up some distance apart, so that the same vehicle cannot activate both sensors simultaneously. The pulses produced by the two sensors as the vehicle passes are not only fed to the XOR gate but are also used to determine whether the counter section should count up or down.

The counter section consists of two cascaded 4510B up/down binary counters (IC2 & IC4). It works like this: if Sensor 1 is activated first, the U/D inputs of the counters are pulled high (by a 100kΩ resistor) and IC1a clocks IC2 & IC4 in the up direction (ie, the count is incremented). Conversely, if Sensor 2 is activated first, the U/D inputs are held low (by LDR1) and IC1a clocks the counters in the down direction (ie, the count is decremented).

IC2 & IC4 in turn drive BCD to 7-segment display drivers IC3 & IC5. These then drive two common-anode 7-segment LED displays via 330Ω current-limiting resistors.

Finally, 555 timer IC6 is wired as a monostable with a pushbutton switch S2 connected to its trigger input. This can be used to manually decrement the count from any value by just pressing the switch and is provided to alter the count when the unit is serviced.

R. Subramanian,
Chennai, India. ($45)

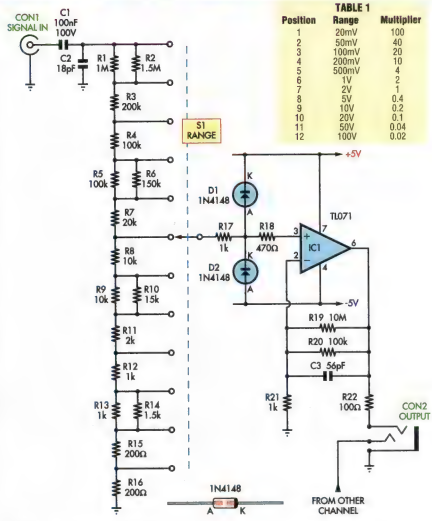


TABLE 1

Position	Range	Multiplier
1	20mV	100
2	50mV	40
3	100mV	20
4	200mV	10
5	500mV	4
6	1V	2
7	2V	1
8	5V	0.4
9	10V	0.2
10	20V	0.1
11	50V	0.04
12	100V	0.02

Test interface for PCs

This circuit is a modification of the "Sound Card Interface for PC Test Instruments", published in the August 2002 issue of SILICON CHIP. The modification increases both the range and the sensitivity of the instrument.

In this circuit, the gain of the TL071 op amp ICs has been increased from 10x to 100x (exactly) and the range switch has been modified from six positions to 12 positions, ranging from 20mV to 100V (instead of the previous 200mV to 10V). The input impedance has been kept at 1MΩ, as before.

The existing resistive divider chain is largely unchanged except for the original "earthy" 20kΩ resistor which has been changed here to 10kΩ (R8). The gain of each position is different though. Additional resistors have then been added to the bottom of the divider chain, to make up the additional six positions.

The programmable 6-position range switches (S1 and S2) should have their stop washers removed altogether, to allow all 12 possible positions. The two previously unused switch positions that were earthed on the PC board must also be isolated, as these positions are now used.

The 20kΩ resistors that were at the earthy end of the range switch (and located at the extreme left and extreme right of the PC board) must be removed and discarded from the circuit.

R8-R16 (on my circuit) were added on the back of the PC board in series/parallel around the six new switch positions, starting with R8 (10kΩ) where the previously removed 20kΩ resistors were located and ending with R16 (200Ω) which connects to earth.

The original 27kΩ resistors between pins 6 & 2 of the TL071s have been replaced with R19 (10MΩ) and R20 (100kΩ) in parallel. These two values alter the gains of the op amp stages to 100. In addition, the 3kΩ resistors from pin 2 of the TL071s to ground are replaced with 1kΩ resistors.

Table 1 (see circuit) lists the input voltage range for each switch setting and its corresponding multiplier value (assuming a x1 probe).

Note that although the greatest input attenuation now takes place on the 100V range (instead of 10V), the maximum input voltage capability of the instrument has not been increased – ie, it is still 100V. The only difference is that now you do not have to use a probe set to divide by 10 to measure voltages up to 100V.

The existing shielding should work fine but I fitted a shield to the top of the PC board as well, as the unit is now also 10 times more sensitive to noise. In practice, I used a case that had an aluminium top and this was earthed.

Finally, some trivia on computer sound cards. First, background noise or hash is unavoidable when using an internal sound card. This noise is worst on the microphone input because of the higher gain required. A low-impedance microphone is less prone to noise but most cheap sound cards have a high-impedance input only and so a low-impedance microphone delivers little signal.

Second, sound cards integrated onto the motherboard are generally noisier than PCI-slot cards. An external sound card (eg, a USB card that's outside the computer case altogether and away from the noise-generating bits) is the best solution but the most expensive.

In any case, try to feed the sound card with the highest input level possible (without distortion). This will help keep the background noise to a minimum.

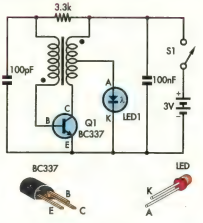
Philip Chugg,
Launceston, Tas. ($40)

White LED torch driver circuit

The performance of this 6-component white LED torch driver circuit is as good as that of much more complicated circuits. And because there are so few components, it can be built into the space normally occupied by the bulb and reflector.

The LED used in the prototype was an ultra-bright type with a 20° beam width. This gives a beam that's similar in width and brightness to the original incandescent bulb (but with greatly increased battery life). Alternatively, a 50° LED would be preferable for applications such as map reading.

The circuit is a blocking oscillator used as a flyback converter. When power is applied, current flows through the 3.3kΩ resistor and turns Q1 on. Positive feedback via the transformer then forces the transistor into saturation.



As it does so, the collector current rises linearly (at a rate determined by the inductance of the transformer's primary), until the base current is no longer sufficient to maintain saturation. Positive feedback from the transformer then cuts Q1 off and the collector voltage rises rapidly until it is clamped by LED1 turning on. The energy stored in the inductor is then dissipated by current flowing through the LED.

When the transformer current has fallen to a low value, the cycle repeats. As a result, the circuit oscillates at around 90kHz.

The transformer is wound on a type 4C65 ferrite toroid measuring 9.4mm (OD) x 3.4mm high (Farnell Cat. 200-604). The tapped primary winding consists of 5 + 5 turns, while the secondary consists of 10 turns of enamelled copper wire (the wire gauge is not important but the phasing must be correct).

The assembly can be constructed "birds nest" fashion and then potted in silicone rubber for protection, leaving just the LED and battery leads exposed.

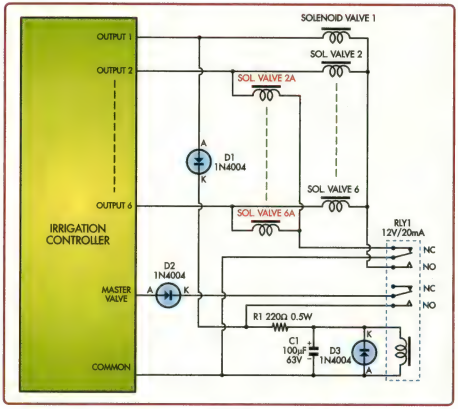
Tony Ellis,
Porirua, NZ. ($30)

Adding outlets to an irrigation controller

Here's an easy way to expand the number of outputs from a 6-station irrigation controller. The circuit relies on the use of a commercial irrigation controller that's capable of providing multiple programs during one day. It's not suitable for controllers that don't offer multiple programming.

To expand the number of outputs, relay RLY1 is used to switch the common returns of the existing six-solenoid valves plus up to five additional five solenoid valves (Sol. Valve 2A-6A). The relay is triggered by output 1 and latched by the "Pump" or "Master" valve output that all controllers have (this output is active when any other output is active and is intended to drive a pump or master valve).

In operation, the controller is programmed to activate outputs 1-6 on one program cycle and outputs 2-6 on a second cycle, the latter timed to start after the first cycle has been completed. The short time between program cycles causes the latching contacts to release the relay and the absence of a trigger from output 1 on the second cycle prevents RLY1 from turning on. As a result, RLY1 now selects the added bank of solenoid valves via its NC contacts.



Diodes D1 & D2 isolate the Master valve output from Output 1, while D1, C1 and R1 allow a common 12V DC 20mA relay to operate from the standard 24V AC supply that commercial controllers use. D3 prevents relay switching spikes from damaging C1.

Mike Shaw,
Nelson Bay. ($45)

By JULIAN EDGAR

Big Blaster Subwoofer

Capable of thunderous bass, this easy-to-build subwoofer can handle up to 250 watts RMS and uses a compact 37-litre enclosure.

The driver used in the subwoofer is 10 inches (25.4cm) in diameter, is rated at 125W RMS and uses a voice coil that's 50mm in diameter. It costs $99 (you need two for this design) and is available from Jaycar.

The enclosure is constructed by marrying two of these pre-made Jaycar boxes together. Each box has an internal volume of 23 litres and is supplied fully carpeted, with the speaker hole precut and speaker terminals fitted.

IN MARCH 2003, we presented the "Little Dynamite" subwoofer – an easy-to-build design that used a single 10-inch driver in a 25-litre ported enclosure. At the time, we said that we'd later be describing a larger, higher-powered subwoofer and this is it.

This new subwoofer is a flow-on from the previous design, where many different enclosure variations were modelled using BassBox speaker design software. It uses not one but two 10-inch Jaycar drivers, two 25-litre pre-built sealed enclosures and two ports. The two 25-litre enclosures are combined to make one unit with a capacity of 37 litres and we'll look at just how this is done shortly.

The resulting enclosure is longer than before and this has allowed us to use longer ports. This, in turn, has allowed the box to be tuned to a lower frequency which benefits the bottom-end response. In addition, the use of two drivers increases the sensitivity and power handling of the finished subwoofer.

Another benefit of the new design is that if you built the previous unit and want to upgrade, you can do so without starting all over again.

Design details

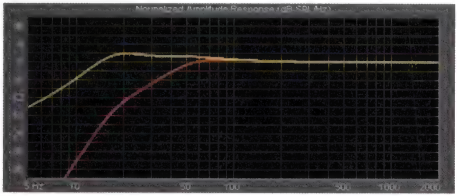
Despite considering fancy isobaric bandpass designs and all sorts of other exotic types, we eventually came back to a simple bass reflex enclosure for this subwoofer. This was primarily because of the cheapness and ready availability of the pre-built Jaycar subwoofer enclosures (they're even carpeted!). These enclosures are priced at just $59.50 each and at that price, they're hard to go past – just assembling the materials to build one would cost you more than that.

As mentioned, we combined two such enclosures for a usable internal volume of 37 litres. Apart from the low cost of the two boxes, this approach has a number of advantages over building something from scratch: (1) the panels are all small in area and so the stiffness of the finished enclosure is quite high; (2) very little woodworking needs to be done and any that is required isn't critical in nature (ever tried to cut out the hole for a loudspeaker? – it's harder than it looks if you want to do a good job!); and (3) the long, thin design that results is – while unconventional – very suitable for car and home use.

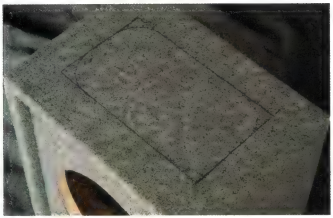
Main Features

- Easy to build
- 250 watts power handling
- Suitable for both home and car
- Versatile wiring allows both 4-ohm and 2-ohm connections
- Excellent frequency response

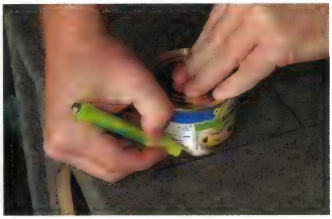
On the latter subject, the overall dimensions of 900 x 340 x 250mm allow the subwoofer to fit up against the back seat in most sedans and hatches (we measured a WRX, a 200SX and a Commodore – plus several other cars – and the 200SX was the only



The response of the subwoofer, as predicted by the BassBox speaker design software program. The yellow line shows the response for an in-car environment, while the red line shows the modelled response within a room.



The end panels of each enclosure are marked and then cut out as described in the text. This opening allows air to freely pass along the length of the enclosure and gives room for the long ports.



Using curved corners in the cut-out gives room for the nuts and bolts which will later join the two boxes – and also makes it easier to use the jigsaw. A food can that's just the right size makes a convenient hole marker.

tight one). In a home application, the long, thin design can be easily slipped behind a chair or it can be fitted with feet and placed upright in a corner (the feet are required to give port clearance).

As before, the drivers used in the design are the Jaycar CS-2274. These are 10-inch units with 125 watts RMS power handling, a maximum cone movement of 9mm, a voice coil diameter of 50mm and a resonant frequency of 33Hz. They cost $99 each.

The boxes that are "siamesed" together are the 25-litre (actually 23 litres) CS-2520 sealed subwoofer enclosures. Note that although ported versions of these enclosures are available, it's better to start with the sealed boxes and cut the port holes as required, to suit the special ports used.

The enclosures are first modified by cutting a panel out of the end of each, then joining them together with sealant and nuts and bolts. This makes a strong, airtight enclosure. The ports are the Jaycar CX-2688 flared ports, which can be easily adjusted in length by adding 65mm-diameter plastic pipe. The flared section is used at both ends of each port, reducing the chance of port noise that could otherwise occur as air flows around the sharp inner edge.

Optimising the bass

The bass response is optimised by tuning the enclosure to 26.5Hz using two 600mm-long, 63mm internal diameter ports. Modelled using the BassBox software, this combination of tuned box frequency, 37-litre box volume and specified 10-inch drivers, gives an in-car frequency response that is quite strong down to 20Hz.

Inside a home, the modelled bass response rolls off by 3dB at 40Hz. However, there is sufficient cone excursion left that this can be boosted to give bass that is audible down to 30Hz.

Even more importantly, the use of the twin drivers and long ports allows much louder bass for the same input power: at 100W input power and at 20Hz, the modelled output is 5dB greater than the previous single-driver design. However, as noted before, these drivers are not very sensitive units – so you'll still want an amplifier capable of at least 100W RMS per channel (more on this later).

Building it

The first step is to line up the two enclosures end to end. To do this, place the boxes so that their terminal strips are uppermost, then move them apart again. The sides that were touching are the ones that have to be cut

Once the opening has been cut out, align the two enclosures and drill four holes for the attachment bolts (yes, I did drill one hole in slightly the wrong place!). That done, use a sharp knife to cut away a piece of carpet all around the opening.

Once the carpet has been cut away, apply water clean-up Liquid Nails (or a similar building adhesive) around the opening. As the two box halves are forced together, this adhesive will seal the gap, in addition to providing more strength for the join.

This view shows one of the four nuts and bolts that hold the two halves of the enclosure together. Notice how the Liquid Nails that has squeezed from the join has been spread along the internal ribs to ensure an airtight seal.

The ports are positioned towards the back of the enclosure with their openings at either end (one at the top and one at the bottom). They require an 85mm-diameter hole and this should be positioned 40mm in from the box edges.

open so that when they are later joined together, one large enclosure is formed.

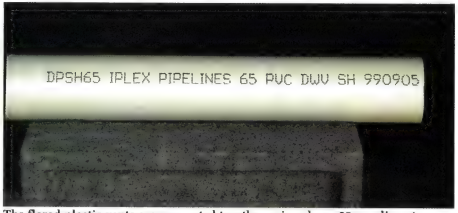
On each of these sides mark a line 50mm in from the top, back and bottom and 65mm in from the front edge. That done, drill a hole in each panel to take a jigsaw blade and then cut out the panels, following the lines that you have marked. Note that this will leave a "rib" around each of the openings. This rib not only helps strengthen the final assembly but also accepts the connecting bolts.

To join the boxes, first hold them in perfect alignment, then drill four holes – one through each corner of the ribs. That done, good-quality nuts, bolts and washers can be used to rigidly fasten the two enclosures together. However, before you do bolt them together, remove a strip of carpet from around the opening and then run a bead of water clean-up Liquid Nails (or some other similar sealant/adhesive) around the join. Make sure that you don't use too much or it will squeeze out from the outside of the join and look ugly.

The carpet that's still present between the surfaces will compress as you tighten the bolts, so go right around them three times, tightening them up. After that, you have to let the adhesive set – preferably overnight.

Cutting the ports

The next step is to cut the holes for the ports. Two are used – one at each end of the enclosure. Note that these ports must be at the back of the box so that they clear the speaker magnet assemblies, one positioned at the top and one positioned at the bottom (so that they don't interfere with each other).



The flared plastic vents are connected together using cheap 65mm-diameter plastic pipe (see text). This makes it easy to construct ports of the required size and flow characteristics.

The first step is to use a round or half-round file to remove the sharp inside edge from the preformed flared ports (ie, at the non-curved ends). This is done to eliminate any sharp steps between the flared vents and the plastic pipes when they are later joined together. Finish off the job using some fine sandpaper.

The sharp "steps" that would otherwise occur in the transition from the flared port to the plastic pipe are smoothed using a half-round file and some fine sandpaper.

With these edges smoothed, cut each plastic pipe to the correct length (about 520mm) so that when both flared ends are pushed firmly into it, the total length of each port is 600mm. Don't be tempted to glue the flared vents to the plastic pipe at this stage, though – that step comes later.

Once the ports have been temporarily assembled, spray some black paint inside them to hide any scratches that you have made and to hide the white plastic.

The next step is to cut the holes for the ports. An 85mm diameter hole is ideal – we drew the two cutouts with the help of a can of food that conveniently had the right diameter. The holes should be positioned with their edges about 40mm in from the edges of the box.

If you place the port opening fur-

How To Make The Brackets To Hold The Ports In Place

(1) Start by cutting off a surplus length of the 65mm plastic pipe. It should be about 30mm wide.

(2) Use a hacksaw to make a longitudinal cut along the 30mm pipe section.

(3) Use a heat-gun to soften a little less than half the diameter. Flatten this piece out (careful – it's hot!).

ther in from the edge, you will find it easier to miss the internal rib with the long ports – but you'll also be getting closer to the magnet assemblies of the woofers. A trade-off is to mark where the plastic pipe touches the internal rib and then soften this area on the pipe with a heat gun (done with the port out of the box!).

It will then be easy to compress the port pipe a smidgin at this spot to give better rib clearance. The port volume and flow changes will be only tiny but the tweak makes it all a bit easier to fit everything in.

Gluing these long ports into place is not sufficient to secure them – you will also require brackets to hold them rigidly inside the box. An effective bracket can be easily made by first cutting off a 30mm surplus length of the 65mm-diameter plastic pipe. That done, square the ends and then make a single cut longitudinally along the section.

Next, using a heatgun, soften the pipe to one side of the cut and then bend that section outwards (use oven mitts as the pipe is hot!). With a bit more heatgun work, you should end up with a bracket which wraps itself at least halfway around the port. The other end of the bracket is attached to the inside of the enclosure using short self-tapping screws.

You will need one bracket for each port and they can be glued to the port tubes using Liquid Nails (or similar) building adhesive. In addition, a generous amount of adhesive should be placed around the back of each flare that faces out of the enclosure, while additional adhesive is placed on the ports where they sit on the internal rib.

Finishing off

Once the ports are in place, acrylic speaker damping material can be cut to size and stuck to the inner walls of the box. We suggest 350 grams/square metre material (Jaycar AX-3690) but any similar material is fine – eg, acrylic quilt wadding. Be careful that you don't block the entrances to the ports

Connecting The Drivers

The two woofers can be driven in parallel from one amplifier or they can be driven separately by a stereo power amplifier but there are a number of traps here. If you get it wrong, you could blow your amplifier.

If you want to drive the woofers in parallel, they will constitute a 2Ω load. Many car subwoofer amplifiers will happily drive a 2Ω load, so that is one option.

A second option is to use the two channels of a stereo amplifier to drive each woofer separately (4Ω loads). Or, if you have a 4-channel car amplifier which can be bridged to drive 4Ω loads, then you can use that to again drive each woofer separately.

What you must not do is connect a stereo amplifier in bridge mode to drive the two 4Ω woofers in parallel; ie, a 2Ω load. In this case, the separate "bridged" amplifiers will each "see" a 1Ω load – most amplifiers cannot drive a 1Ω load and will blow fuses or be seriously damaged.

When running the subwoofer in 2Ω mode, simply connect the two drivers in parallel. To do this, connect the power amplifier to one set of the speaker terminals and then run more cables to the other speaker terminals, making sure that you connect positive to positive and negative to negative. An amplifier driving a 2Ω load will deliver more power than it does into a 4Ω load.

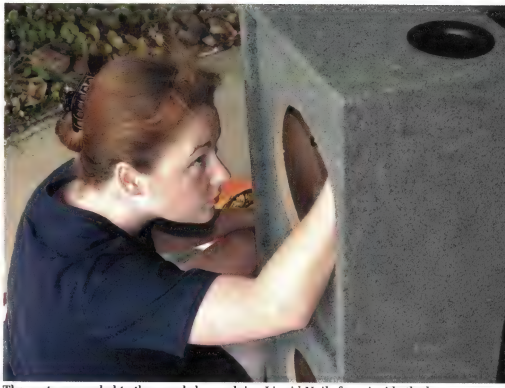
4-ohm load

If you want to configure the subwoofer as a 4Ω design, you'll need a 2-channel amplifier. One channel connects to one set of terminals on the subwoofer, while the second channel connects to the other set.

Note, however, that you must feed a mono signal to the subwoofer amplifier; eg, by using a Y-connector lead on the input. In other words, both channels of the amplifier must be driven by the same signal.

If you have a single subwoofer output from a head unit or other source, this should be fed into one end of the "Y" cable which then connects to each amplifier channel. Make sure that you get the phasing right – ie, connect positive to positive and negative to negative. If you have the phasing to one of the drivers reversed, there will be a distinct lack of bass.

(4) Twist the tail to form a mounting foot for the clamp. Each port is held in place by attaching one of these clamps to the centre rib of the enclosure.



The ports are sealed to the panels by applying Liquid Nails from inside the box. It's a lot easier if you have small hands, so at this point a helper may need to be press-ganged into action.

– in fact, it is wise to be quite sparing in your use of the material around the port entrances.

Next, solder some heavy-duty speaker cable to the terminals and attach the other ends to the screw terminals on the drivers. Keep this wiring completely separate – each pair of terminals connects to its nearest driver. Be sure to connect the positive terminals to the positive terminals on the drivers; similarly, the negative terminals go to the negative speaker terminals.

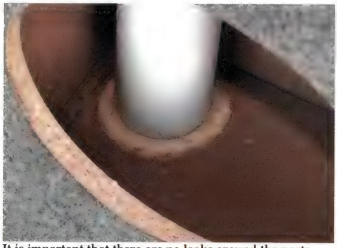
Once the wiring has been completed, the drivers can be slipped into their precut holes and the locations marked for their mounting screws. That done, remove the drivers and drill small diameter pilot holes for the screws. If you're fitting metal grilles, you should also drill the holes for their mounting lugs and attach the T-nuts under the front panels at this point.

Finally, reinstall the drivers and fasten each into place using eight coarse-thread MDF screws. As before, the carpet will compress as you tighten the screws, so go around each driver and re-tighten it at least three times.

Phasing

This step is very important in this design – apply a 1.5V battery across each set of external terminals in turn (positive to positive and negative to negative) and check that the corresponding woofer cone moves forwards in each case. If a cone moves backwards when the battery is applied, open up the enclosure and swap the wiring connections to the relevant driver.

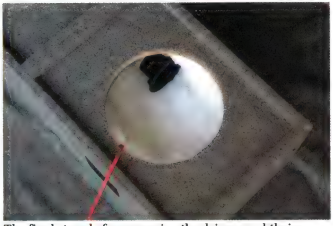
The next step is to connect the subwoofer to an amplifier (see panel).



It is important that there are no leaks around the ports, so make sure that the sealing is well done. Any leaks here can cause whistles. Similarly, there must be no leaks around the edges of the drivers.

This view shows the two ports in place inside the enclosure. Note the supporting brackets – these are in addition to adhesive which is placed directly on the ports to secure them to the internal rib.

As can be seen in this overall view, the ports extend into the opposite ends of the enclosure. The clearance between the ports and the magnets of the drivers is quite tight – make sure that they don't touch.



The final steps before screwing the drivers and their grilles into place are to solder the cable to the terminals and then place the acrylic speaker filling along the internal walls. Make sure that the port entrances can't be blocked – hold the acrylic filling in place with a few dobs of adhesive.

Parts List

2 10-inch Response Subwoofers (Jaycar Cat. CS-2274)
2 25-litre sealed subwoofer enclosures (Jaycar Cat. CS-2520)
1 acrylic speaker damping material (Jaycar Cat. AX-3690)
2 10-inch protective grilles (Jaycar Cat. AX-3522)
4 flared speaker ports (Jaycar Cat. CX-2688)
4 2-inch x 0.25-inch bolts, nuts and washers
1 150cm (approx.) length 65mm-dia. plastic pipe
1 0.5m-length of heavy-duty speaker wire
1 tube building adhesive; eg, Liquid Nails
16 speaker attachment screws

Once it's connected, begin by driving the unit quite gently. Moisten a finger and move it around the edge of each driver, to check for any air leaks around the frames. Now do the same around the edge of each port – there will be air movement within the ports but there shouldn't be any around the edge of the flares.

Next, listen carefully for any buzzes, rattles or whistles. If everything is OK, wind up the wick a bit more. Naturally, during this test procedure, all other speakers should be disconnected so that you're just listening to the subwoofer. This will allow you to easily identify any problems.

A good test is to drive the subwoofer from the soundcard in your PC and download some free audio frequency generator software from the Internet – eg, the NCH Tone Generator from **www.nch.com.au/tonegen/index.html**.

Alternatively, you can just download the software and burn some test tones onto a CD so that the subwoofer can be checked in a car.

Using the software, you can generate sinewave signals at all sorts of audio frequencies. The first use for this is to determine the range of frequencies that are audible. In the case of the prototype (tested in a 5 x 4-metre room), there was strong bass down to 40Hz and audible bass at 30Hz.

It was also clear that the cones became dramatically unloaded at about 25Hz – the exact frequency depending on the power being fed to the subwoofer. That means that a subsonic filter should be used if the subwoofer is going to be driven hard.

The other use of the software is to check for peaks and troughs in the frequency response. This can done by doing a slow sweep across a range of frequencies – eg, from 150Hz down to 25Hz. However, these peaks and troughs will also be affected by the listening environment.

In the case of the prototype, there were minor peaks at 67Hz and 100Hz. Note, however, that high SPLs (sound pressure levels) shouldn't be maintained when using sinewave signals. In other words, be careful that you don't wreck the drivers by driving them or the amplifier into distortion while doing this testing.

Conclusion

The use of the pre-built boxes really does make this design dead-easy to make – you should be able to put it together in just a few hours. The end result is an impressive subwoofer, especially considering its cost and overall size. **SC**

NEW KITS OF THE MONTH

NO FRILLS PICAXE PROGRAMING KIT

PIC-AXEALL KIT: This development kit can be used to program or run most PICs and all PICAXE Chips plus other chips. Features includes 28 pin chip socket, large tinned copper pads with component holes, low cost all-in-one programmer, simple and easy to assemble. Kit includes a small PCB, Piezo speaker, 5.5V Plugpack and all on-board components. For more information and softwares check the following website www.picaxe.co.uk. (PAE01)$12.50

PICAXE-08 CHIPS

The PICAXE processors use a R.I.S.C (Reduced Instruction Set Controller) system, & are easy to program. It is like a Basic Stamp clone in single chip.
PICAXE-08 IC: (PICAXE-08) $3.90
PICAXE-18A IC: (PICAXE-18A) $9.40
PICAXE-28A IC: (PICAXE-28A) $14.40
Lots of info available on the internet.

VALVE PRE-AMPLIFIER KIT

Bring back the warmth of that old valve pre-amp with this simple to build kit. It requires a single 9Vac or 9-12dc supply, The single PCB can be cut to separate the power supply section of the circuit. Kit includes power adaptor, PCB, and all onboard components including RCA connectors & valve. k188A $33

UHF REMOTE CONTROL / UHF REMOTE CONTROLLED SIREN:

This very loud siren is remotely controlled by a small key-chain transmitter: Press once for ON press again for OFF. The siren contains two PCB's, 1 x UHF Receiver PCB and 1 x Siren PCB. There are two wires interconnecting these so the siren-UHF receiver can easily be separated to serve as stand-alone units. The Motorola encoder IC used in the transmitter is an MC145026 and its matching MC145028 is used in the receiver. These are both readily available. The whole kit is supplied in its original packing and it also includes a 12V cigarette lighter lead, and suitable Australian power adaptor. The unit is new and guaranteed except for the batteries. In a few units tested the 12V lighter battery in the transmitter was OK but the 8.4V Nicad back-up battery in the siren needed charging. Siren-RX: 30M range, 6-13.8V operation, 1mA stand-by, 120dB output, 500mA consumption when on.

LONG RANGE 4 CHANEL UHF TRANSMITTER & RECEIVER KITs

These kits uses pre-built and pre-aligned (pre-tuned) UHF modules, this means easy assembly and no fiddly tuning or mucking around trying to make it work. We tested these kits at 1.8 Kilometers in an industrial area and we were surprised at the strength of the signal. The 4 push buttons on the transmitter kit can be removed and replaced with a with a connection carrying data from a PC or other device (5V logic). It will accept any single or multiple button press or BCD data, with a BCD decoding chip attached to the receiver kit it could control up to 16 outputs. Kits includes PCB, UHF module and all onboard components.
Transmitter K190A $22
Receiver K190B $32

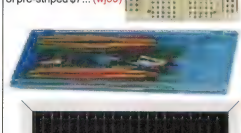
EXPERIMENTERS BREADBOARD

The ideal way to prototype electronic circuits without solder. $9... (bb301)

WIRE JUMPER PACK

This 79pc jumper pack contains multiple lengths of pre-striped $7... (wj59)

WARNING!!! These magnets are so strong they are dangerous!!! new neodymium rare earth magnets.
Dew to popular request we have introduced some smaller magnets to our range similar to those used in magnetic therapy etc. 20 X 10mm$6.00... 10 X 5mm$1.20... 10 X 3 mm$0.70... 7 X 3mm $0.55... 7 X 2.5mm$0.45... 3 X 2mm $0.25... 3 X 1.5mm$0.20.



SYDNEY 2000 OLYMPIC VIDEO: "16 Days in September - Games Highlights of the XXVII Olympiad"

intro by Ian Thorpe. Juan Antonio Samaranch said "I am proud & happy to proclaim that you have presented to the world, the best Olympic Games ever." It wasn't just the IOC's opinion. Sydney 2000 didn't just receive universal acclaim, it was the games that restored the people's faith in the Olympic movement. A global entourage of 11,000 athletes from 200 nations, were assembled in Sydney, for the quest of Olympic performance supremacy, & the medals that confirmed it. From the glorious backdrop, of Sydney Harbour for the 1st Olympic triathlon, to the focus on "Torpedo" the biggest star in the pool. The achievements of Cathy Freeman, Ian Thorpe, Michael Klim, Susie O'Neill, Grant Hackett, Kieren Perkins, Michael Diamond, & our successes are captured here, in tribute to our outstanding athletes. All this and more as we re-live those 16 Days in September. $9.90

NEW PRODUCT BARGAINS

12VAC PUMP

Why spend a small fortune on a new water feature when you could build your own. Comes complete with 240V power adapter. Pumps a head of up to 500mm at 300L p/h via a 8mm outlet. (PP1)

MINI FOG MACHINE

Great for water features and humidifies and ionizes the air. This safe low-voltage fogger is fully submersible and comes complete with a 30W, 24vac mains power adapter. It uses ultra-sound to agitate the water and generate fog. Features include 12 super-bright LEDs that change colour. Available at the end of May

LOTS OF OPTICAL BARGAINS HIGH POWERED LEDS, LASERS POINTERS & LASER DIODES

BULK LED SPECIAL
20 or more red LEDs for $0.60ea
20 or more white LEDs for $1.70ea
10cD White...$2.00 ea Red...80c ...70c
Green...$2.10 Blue...$2.20 UV LED's...$1.60

DON'T PAY A SMALL FORTUNE

These fantastic little devices will hold much more data than a floppy disk and have much better data retention. How many times have you lost data on a corrupted floppy? Or the file is too big to fit a floppy disk?

16M... $24... (16md)... holds more than11 floppies.
32M... $29: (32md)... holds more than 22 floppies.
64M... $49: (64md)... holds more than44 floppies.
128M... $82: (128md)... holds more than 88 floppies.

HOW ABOUT A COMPLETE SOLAR LIGHTING SYSTEM FOR YOUR CAMP, CARAVAN OR WEEKENDER:

There are 4 main components to this system, 2W Solar Panel, Switching Solar Regulator kit, Battery and 2 X 10 LED Lamp Kits. This combination of solar panel, charger and battery will power 1 of the LED lamp kits for over 7hrs with only 5hrs of sunlight. Central Australia receives around 10 hrs per day. (SL2W):$99
UPGRADE TO A BIGGER PANEL!! For just $25 more.
You can upgrade from a 2W to a 4W panel in your Solar Lighting System . (SL4W) total price.$124

www.oatleyelectronics.com Suppliers of kits and surplus electronics to hobbyists, experimenters, industry & professionals.
Orders: Ph (02) 9584 3563, Fax 9584 3561, sales@oatleyelectronics.com, PO Box 89 Oatley NSW 2223
major credit cards accepted, Post & Pack typically $7 Prices subject to change without notice ACN 068 740 081 ABN18068 740 081

The new Luxeon LEDs:

by Julian Edgar

The BRIGHTEST White LEDs on Earth!

So you think that the latest crop of 5mm white LEDs are bright? Well, to quote that old cliché: you ain't seen nothin' yet, folks!

US manufacturer Lumileds Lighting has developed a whole new breed of LEDs – they use new technology, they look quite different and they produce more light than we have ever previously seen coming from a LED. The new LEDs are branded Luxeon.

The manufacturer's publicity suggests that the Luxeon LEDs are the start of a lighting revolution – and to an extent we agree. "Luxeon is today's brightest solid-state light source, producing 10-20 times the output of a standard LED lamp," suggests the company. "With a white source efficacy of 25 lumens/watt]. . . Luxeon is a realistic source for general and directional lighting."

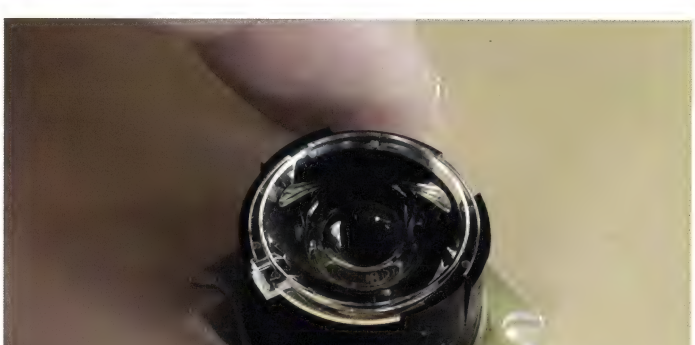
It is almost impossible to photograph either of the Luxeons in action – and do their amazing light output justice. Here the current to the 1W LED has been reduced, the camera has been placed well off-axis – and bad lens flare has still occurred.

Lumileds claims that the LEDs can be integrated into light fixtures – after all, with a rated life of 50,000 hours (other data suggests "up to 100,000 hours"), the 'bulb' probably never needs to be changed. Their publicity material shows the LEDs being used for internal commercial lighting and outside architectural lighting, in addition to emergency and portable lighting.

However, Lumiled's engineers are a little more conservative. "Today there is really no such thing as a commercial 'solid state lamp' for use in illumination," they state in an IEEE paper. "However... differences are beginning to appear in the technologies used for low-power LED indicators and the high-power LED light sources that will evolve into lighting sources."

So what are the new technologies? And do the Luxeon LEDs live up to their publicity hype?

We won't be able to make a judgement on their life for nearly six years



The Star/O is a 1W LED which has a built-in collimator to provide a focused beam. The resulting package is extraordinarily bright and easy to use.

(and only then if they are on continuously!) but having bought two different versions of the Luxeon LEDs, we can state categorically that these little beasties are simply awesome. Phenomenal. Bright enough to blow away any thoughts you might still have that LEDs are good only for panel indicators, not for illumination.

The LEDs can provide so much light that – with the right optics – a beam with a reach, brightness and whiteness can be created that puts a battery-operated handheld spotlight to shame. Yes, that bright!

The technology

Conventional 5mm LEDs are not very suited to high light outputs – understandable since their packaging was never designed for this purpose. These LEDs use a small chip mounted in a reflector cup, with the entire device encased in an epoxy which is also shaped to act as a lens.

The disadvantages of this approach relate mostly to dissipating heat – a high thermal resistance and an epoxy limited to a maximum temperature of about 120°C results in a maximum input power of about 0.1W. (Consider a 5mm white LED that might have a maximum current of 20mA at 3.5V – that's 0.07W).

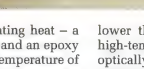
The Luxeon LEDs use completely different packaging. A larger LED chip is used and it is mounted on an aluminium or copper slug, resulting in a thermal resistance about 17 times lower than a conventional LED. A high-temp soft gel inner encapsulant optically couples the LED chip to a plastic lens.

In addition, Luxeon LEDs use InGaN (Indium Gallium Nitride) materials constructed in a so-called 'flip-chip' structure that gives the following benefits:

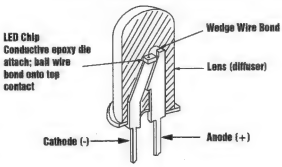
The bulk of the light is extracted through the substrate rather than being attenuated through a partially absorbing layer as occurs with a conventional LED;

- Metallisations within the LED structure give low resistance contact to the GaN and act as excellent optical reflectors;
- The thin current-spreading layer in a conventional LED is replaced with a thick, opaque metallic contact, allowing increased current densities;
- Wire bonds over the top of the device are not used, reducing the ab-

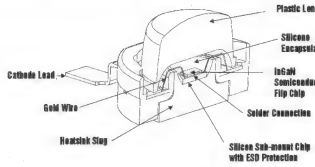
Safety!



The Luxeon LEDs are so bright that they are officially categorised as a Class 2 Laser Product. You should take great care not to look directly into the beam and in any application that is made of the LEDs, shielding should be provided so that end users are similarly protected. When working with the LED make sure that the LED cannot be inadvertently turned on when you are looking closely at it.



A conventional 5mm LED package has a high thermal resistance and temperature-limited epoxy which help limit the maximum input power. *[Lumileds]*



The Luxeon high power LEDs use packaging which is much better at shedding heat. A more efficient internal architecture is used and ESD protection is incorporated. *[Lumileds]*

sorption of light within the package;

♦ The LED can be scaled-up in size without electrical resistance or light extraction losses disproportionately increasing.

Lumileds state that the 'flip-chip' approach is 1.6 times as efficient as a standard power LED, both over the whole range of visible wavelengths and with forward currents of 25-1000mA.

The Luxeon LEDs use a phosphor-converted approach to generating white light – a blue LED is used to pump visible light-emitting phosphors integrated into the package.

However, in the Luxeon white LEDs the phosphor granules are applied in a thin conformal layer – rather than being heaped into place – which gives better colour accuracy.

Electrostatic discharge (ESD) protection is built into the LED – shunt diodes are located within the submount that provide electrostatic protection from up to 16kV (human body model) or 2kV (machine model).

Two different groups of LEDs are available: a 1W device that uses a 1mm x 1mm chip and an incredible 5W LED that uses a 2mm x 2mm chip.

The 5W LEDs have internal Lumileds' performance records of a drive current density of 50 amps per square centimetre, an efficiency of 44.3 lumens/watt and a flux output of 187 lumens.

The 1W Star/O

One of the most useful packages is the Star/O. This is a 1W Luxeon LED mounted on a 25mm square piece of aluminium-core PC board. A collimator (focusing lens) constructed from optical grade acrylic results in a beam narrower than would otherwise be obtained.

Wiring connections are made to solder pads placed on the upper surface of the PC board, with the positive connection represented by a small dot or '+' sign.

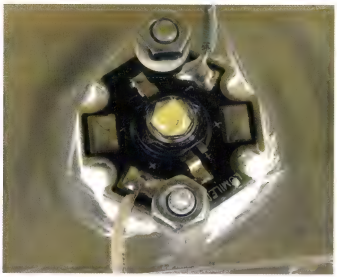
The LED assembly can be mounted by small machine screws placed through the U-shaped cut-outs provided on opposite corners of the PC board.

The beam produced by the optics has a viewing angle of 10° (defined as the off-axis angle from the centreline where the luminous intensity is half of the peak value). On axis, the 1W Star/O has a typical brightness of 180 Candela.

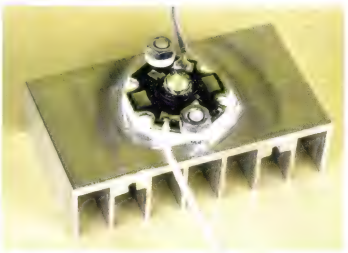
No, that's not a misprint: 180 Candela (or 180,000mCd....)!

The LEDs use an aluminium heat-conducting PC board. The wiring connections are on the other side, allowing the LED to be easily mounted on a heatsink.

The collimator is a Total Internal Reflection design made from injection-moulded acrylic. It has an optical efficiency of up to 90 per cent and can be used with both 1-watt and 5-watt Luxeon LEDs.



This heatsink is too small for continuous use of the 5W Luxeon LED – although it's fine for the short, infrequent use that is being made of this LED. Thermal management of the heat dissipated from the back of the LED is critical to longevity.



The 5-watt Luxeon Star V Portable produces a stunning amount of light. It is mounted on a hexagonal-shaped aluminium PC board with multiple mounting holes and connection solder pads available. It must not be operated without being mounted on a heatsink.

The absolute maximum ratings for the 1W units are 350mA forward current (typically at 3.4V) and a PC board temperature of 105°C. If that temperature raises some eyebrows, stay tuned, because we'll come back to thermal management in a moment.

Out of the box, the Star/O LEDs are ideal for directional lighting such as torches, reading lights and so on.

Although the assembly is far bigger than a conventional LED, the fact that it's a 'complete package' incorporating the light source, optics, solder pads, heatsink and a mounting plate make its applications easy to implement.

When powered up, the LED casts a superbright beam of light – in the room in which I am now working, with the Star/O sitting on my desk pointing upwards, a pool of light about one metre in diameter is thrown onto the ceiling. The light is clearly visible, even with the room brightly lit by two windows...

When viewed on-axis The LED is uncomfortably bright, even from 10 metres away – again, that's inside with daylight streaming in thorough windows.

However, despite the presence of the inbuilt heatsink and the LED's high efficiency, it takes only a few minutes of operation at its peak 350mA before the aluminium PC board is warm to touch – and that's in an ambient of only 24°C.

At the time of writing the Star/O costs $32 from the on-line shop of the Australian Alternative Technology Association (www.ata.org.au).

Considering the number of conventional 5mm white LEDs required to gain the same output (let alone the difficulty of focusing the resulting light) we think that the Star/O is good value – despite the sudden intake of breath that occurs whenever someone first sees that price!

Driving the LEDs

As with conventional LEDs, the forward current through the LED must be regulated. The resistance and power of the resistors used to limit the current flow are selected using conventional LED design procedures, although of course the resistor power dissipation will often be much higher than is normally encountered! Variations in typical values from LED to LED must be catered for in the design, so it's best to measure actual current values with the individual Luxeon LEDs that are being used. Luxeon technical literature suggests that DC (rather than pulsed operation) is the most simple and efficient way of driving LEDs, with pulsed operation used only when the LEDs need to be dimmable.

5W Luxeon Star V Portable

If the 1W Luxeon is impressive, then the 5-watter is perhaps a little frightening. Frightening not only because of the way that you need to be careful to avoid blinding yourself, but also because its thermal demands are very high indeed.

Importantly, the 5W white Luxeon also has a much more limited life than the 1W design – the 5-watter it is rated at only 500 hours.

This is in contrast with the other colours available in 5W versions (green, blue and cyan), which are all rated at up to 100,000 hours.

The LED is sold in a hexagonal aluminium PC board package (shaped in this way to allow easy side-by-side stacking) with multiple screw cut-outs and also multiple solder pads. Centre-to-centre across the mounting cut-outs is 19mm and the assembly stands 7.5mm high.

The LEDs have a forward current of 700ma at a forward voltage of typically 6.8V. The maximum rated temperature of the PC board is 70°C, however a heatsink temperature of less than 35°C is required to retain a 90% lumen output after 500 hours.

And keeping that PC board temperature down is damn hard, let us tell you! Company literature says, "We

do not recommend lighting a 5W Luxeon Power Light Source for more than a few seconds at its rated current without first mounting to an appropriate heatsink" – they're certainly right!

While the 1W LED can be used in cool ambient conditions (especially on a non-continuous basis) without further heatsinking, that is certainly not true for the 5W LED.

An appropriate recommended heatsink is a finned extruded aluminium design with a flat face dimension 44mm x 44mm and with six fins each 38mm long.

The heatsink that we used was about half this size and proved suitable for use when the LED was used with a low duty cycle (ie, was switched on only for short bursts).

With the LED continuously running at maximum rated current for three minutes, the heatsink temperature became uncomfortably warm – a bigger heatsink is essential!

In continuous use it's worth again remembering the point that life will be prolonged if the LED temperature is kept low.

The Luxeon Star Portable comes without focusing optics, however the collimator used in the 1W Star/O is available separately.

With the use of appropriate glue, it is easily mounted on the more powerful LED.

The acrylic optics can be used without problems on the 5W LED; the heat is conducted through the rear aluminium PC board, with the optical surface of the LED (on which the collimator sits) staying near ambient temperature.

And so what is the performance like of the monster LED? Without any optics the LED will dimly light a whole room at night; suspended from a high ceiling it would be completely appropriate as a room illumination if matched with individual spot lighting for reading, etc.

With the collimating optics in place, the effective brightness is of course much higher; we then went a step further and matched this combination with a coated glass lens to give an extraordinary bright spotlight beam.

The 5W Luxeon Star V Portable costs $75 from the ATA while the collimating optics are $6.50 each.

Conclusion

The Luxeon LEDs redefine the current state of the art in LED technology.

While the relatively short life of the 5W Luxeon is disappointing (but it is still much longer than most incandescent bulbs used in torches and the like) and careful thermal design needs to be carried out when using the LEDs, the sheer brilliance of these devices simply has to be seen to be believed. **SC**

Lumileds?

So with such ground-breaking technology, where did the Lumileds company come from? The company can trace its antecedents to the Hewlett-Packard Optoelectronics Division (OED). OED became part of Agilent when Agilent was divided from Hewlett-Packard, and then in 1999 Lumileds Lighting was formed as an Agilent and Philips joint venture.

MicroZed .com.au

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There is more to PICAXE than just the chips. MicroZed have the whole lot on their shelves

PRODUCT SHOWCASE

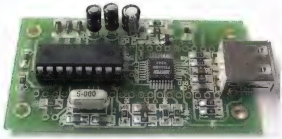
USB PIC Programmer with the lot . . .

In the April 2003 issue of SILICON CHIP, Jim Rowe looked at several PIC programmers from Kits-R-Us. While his overall impression was 'very favourable' he found a few little 'niggles' with the kits.

Peter Crowcroft of Kits-R-Us took the criticisms on board and has come up with a new PIC programmer which not only corrected any problems but can also program ***all*** DIP Flash PIC's.

No external power supply is needed as it gets its power from the USB port.

The software interface and design is by Tony Nixon, who readers may remember designed the astoundingly popular Programmable Ignition System back in the March 1996 and revised in the June and July 1999 issues.



The kit is complete with the 28-pin ZIF socket as shown above right. The only thing you will need to supply is a USB cable suitable for your computer.

The kit is available in Australia from Ozitronics – price is $110.55 including GST and pack and post.

Contact:
Kits-R-Us
Website: www.kitsrus.com
Ozitronics
Website:www.ozitronics.com

Altronics' PortaPAL kit

Altronics will shortly be releasing their long-awaited kit for the "PortaPAL" Portable PA System described in the February and March 2003 issues of SILICON CHIP.

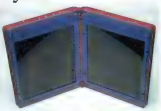
The kit will be short form; that is, it will have all the amplifier electronics including PC boards, components and silk-screened front panel/chassis but will NOT include the speaker box components (timber, carpet, corner protectors, top hat), nor the speaker itself, power supply or battery. (The power supply kit, Cat K1695, is $19.95).

Altronics say they have gone down this route to make the kit as versatile as possible.

The Altronics PortaPAL kit (K-5360) will sell for $179.95 inc. GST and should be available from Altronics stores or via mail order from the beginning of May.

Contact:
Altronics Distributors
PO Box 8350, Perth Busn. Centre, 6849
Ph: (08) 9428 2188 Fax: (08) 9428 2187
website: altronics.com.au

"Power" from Jaycar



Looking for "free" power from the Sun? Or maybe 240V when you don't have mains available? These products from Jaycar Electronics might help. First is a solar charger which opens out like a book and can charge a variety of common rechargeable devices such as mobile phones, digital cameras, hifi gear, etc at a charge rate of about 200mA in good sunlight.

3.6, 6, 9 and 12V outlets are provided. It can also house 4 x AAA rechargeable cells (not included) to become a stand-alone power source.

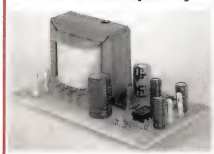
This sells for $59.95 (Cat MB3590).

Second is a range of 12V DC to 230V AC inverters. In the "Powertech" range are 400W, 600W, 800W, 1000W and 1500W models, with retail prices ranging from $199.50 to $749.50. All have electrically isolated outputs for safety. Outputs are modified sinewave so they will power most appropriately-rated equipment.

The solar charger and inverters are available from Jaycar stores and some dealers or via mail/website order.

Contact:
Jaycar Electronics
PO Box 6424, Silverwater NSW 1811
Ph: (02) 9741 8555 Fax: (02) 9741 8500
website: www.jaycar.com.au

AUDIO MODULES
broadcast quality



Manufactured in Australia
Harbuch Electronics Pty Ltd
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fx (02) 9476-3231

Dedicated automotive multimeter from DSE

Dick Smith Electronics have introduced a new multimeter to their already extensive range – this one specifically intended for automotive use.

The Digitor Q1585 meter offers a comprehensive range of tests and checks including RPM, duty cycle, dwell, temperature, frequency, continuity and diode check, along with the "expected" AC/DC voltage, AC/DC current and resistance measurements.

It can handle any number of cylinders from 2-8; RPM to 12,000 and frequency to 32kHz. DC voltage is auto ranging from 32mV to 1000V, (ACV to 750V) while current measurements are from 320μA to 10A.

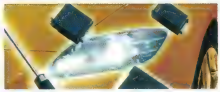
Along with fully-shrouded "standard" multimeter probes, included are a set of alligator clip probes, a thermocouple probe for temperature sensing and an inductive RPM clamp, eliminating the need to break into high tension leads. The standard probes are housed in the back of the anti-shock outer case.

The large-display LCD also includes a bargraph and a "data hold" function is included.

The normal price of the meter is $135.00 but for a limited time is available for $99.94, a saving of $35+. It is available through all DSE stores, mail/web order or selected resellers.

Contact:
Dick Smith Electronics
PO Box 500 Regents Park DC NSW 2143
Ph: (02) 9642 9100 Fax: (02) 9642 9111
website: dse.com.au

TVS for HID lighting



This normally wouldn't get a mention here but we thought it timely given the feature on High Intensity Discharge (HID) lighting in this issue.

Vishay has announced several new devices for transient voltage protection in HID and lighting ballast applications, from 220V to 540V depending on package. The single-chip TVS devices are said to have improved surge capacity, lower leakage currents and improved clamping for high-voltage applications.

Contact:
Vishay Intertechnology Inc
Ph: 0011 1 610 644 1300
website: vishay.com

Marantz Golden Jubilee

Saul Bernard Marantz founded the Marantz Company in New York in 1953, just five years after CBS introduced the first long-playing (LP) record.

As a record collector and amateur musician, he felt that commercial amplifiers were simply not good enough – so he built his own. Strangely enough, Saul Marantz' first commercial product, the Model 1 Mono Preamplifier, included an input for TV audio – thus pre-empting home theatre by half a century!

Today Marantz is part of Japanese company D&M Holdings Inc (the "D" part is Denon), which tends to specialise in mainly high-end audio and home theatre equipment. Marantz is distributed in Australia by QualiFi Pty Ltd and is available at leading hifi specialists.

Contact:
QualiFi Pty Ltd
Ph: (03) 9543 1522
website: qualifi.com.au

Sydney public transport to get Smart (card)?

A project has been announced for Sydney's public transport system which will deliver the first major roll-out of Smart Cards to the Australian public. The contactless card will ease queues and delays on all public transport methods in the greater Sydney area.

The NSW announcement, along with decisions on the Brisbane City Council's and WA transport projects expected to be made shortly, will expedite the development of interoperability standards currently taking place at Standards Australia. The Standard has included input from all State and Territory governments, and members of Intelligent Transport Systems and Asia Pacific Smart Card Forum.

The announcement also flags great opportunities to leverage the system for other applications such as parking, tolling, vending and retail outlets.

Contact:
Asia Pacific Smart Card Forum
Phone: (02) 6247 4655
email: dstanley@aeema.asn.au

World's smallest player/referee transmitter

Have you noticed the number of players, referees, etc who are now "wired for sound" in the big games shown on TV? Ever wondered where they hide their radio transmitters?

A Canadian company, VFGadgets Inc, markets the world's smallest broadcast-quality transmitter. It can be used by the TV networks to broadcast player's, athlete's, or official's audio at any event.

The transmitter has a facility for a microphone to be integral or lavaliere mounted. The transmitter has companding, pre-emphasis and provides high quality broadcast audio.

It measures just 52mm x 32mm x 13mm) and weighs only 28g. The QT-256 has an incredibly small lavaliere microphone only 2mm in diameter. Power output is 100mW, while the frequency is selectable from 690-750Mhz.

And yes, they are rather expensive – at about US$1950 each!

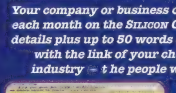
Contact:
VFGadgets Inc
23 Elmer Avenue Toronto, Ontario
Canada M4L 3R6
Tel: 0011-1-416-686-1452
website: vfgadgets.com

SILICON CHIP WebLINK

How many times have you wanted to access a company's website but cannot remember their site name?

Here's an exciting new concept from SILICON CHIP: you can access any of these organisations instantly by going to the SILICON CHIP website (*www.siliconchip.com.au*), clicking on WebLINK and then on the website graphic of the company you're looking for. It's that simple. No longer do you have to wade through search engines or look through pages of indexes – just point'n'click and the site you want will open!

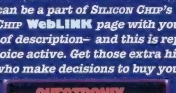
Your company or business can be a part of SILICON CHIP's WebLINK. For one low rate you receive a printed entry each month on the SILICON CHIP WebLINK page with your home page graphic, company name, phone, fax and site details plus up to 50 words of description– and this is repeated on the WebLINK page on the SILICON CHIP website with the link of your choice active. Get those extra hits on your site from the right people in the electronics industry – t he people who make decisions to buy your products. Call SILICON CHIP today on (02) 9979 5644



We specialise in providing a range of Low Power Radio solutions for OEM's to incorporate in their wireless technology based products. The innovative range includes products from **Radiometrix**, the World's leading manufacturer.

TeleLink Communications

Tel:(07) 4934 0413 Fax: (07) 4934 0311
WebLINK: telelink.com.au



At **QUESTRONIX** we specialise in conversion, switching and distribution equipment for VGA, video and audio. We have been serving the audiovisual industry as well as pro, semi-pro and domestic a-v equipment users since 1988. As well as being a 100% Australian manufacturer we also import a range of innovative and interesting items.

QUESTRONIX

Tel: (02) 4343 1970 Fax: (02) 4341 2705
WebLINK: www.questronix.com.au

BitScope is an Open Design Digital Oscilloscope and Logic Analyser. PC software drives BitScope via USB, Ethernet or RS232 to create a powerful Virtual Instrument. BitScope is available built and tested or in kit form. Extensive technical details are available on the website. Great for hobbyists, university labs and industry.

BitScope Designs

Contact: sales@bitscope.com
WebLINK: bitscope.com

PIC chip specialists –
microEngineering Labs and others.
Easy to learn, easy to use, sophisticated CPU based controllers & peripherals.

See our website for new range of ATOM products!

MicroZed Computers

Tel: (02) 6772 2777 Fax: (02) 6772 8987
WebLINK: microzed.com.au

A 100% Australian owned company supplying frequency control products to the highest international standards: filters, OIL's, voltage, temperature compensated and oven controlled oscillators, monolithic and discrete filters and ceramic filters and resonators.

Hy-Q International Pty Ltd

Tel:(03) 9562-8222 Fax: (03) 9562 9009
WebLINK: www.hy-q.com.au

RCS Radio has available **EVERY PC Board** ever published in SILICON CHIP, EA, ETI and AEM (copyrighted boards excepted). Many late boards are available ex stock, others can be made to order within a few days.Custom & production boards too!

RCS Radio

Tel: (02) 9738 0330 Fax: (02) 9738 0334
WebLINK: cia.com.au/rcsradio

For everything in radio control for aircraft, model boats and planes, etc. We also carry an extensive range of model flight control modules including GPS, altitude and speed, interfaces, autopilot and groundstation controllers. More info on our website!

Silvertone Electronics

Tel:(07) 4639 1100 Fax: (07)4639 1275
WebLINK: www.silvertone.com.au

JED designs and manufactures a range of single board computers (based on Wilke Tiger and Atmel AVR), as well as LCD displays and analog and digital I/O for PCs and controllers. JED also makes a PC PROM programmer and RS232/RS485 converters.

Jed Microprocessors Pty Ltd

Tel: (03) 9762 3588 Fax: (03) 9762 5499
WebLINK: jedmicro.com.au

- Hifi upgrades & modification products - jitter reduction and output stage improvement. Danish high-end hifi kits – including pre-amps, phono, power amps & accessories.
- Speaker drivers including Danish Flex Units plus a range of accessories.
- GPS, GSM, AM/FM indiv. & comb. aerials.

Soundlabs Group

Syd: (02) 9660-1228 Melb: (03) 9859-9388
WebLINK: soundlabsgroup.com.au

We stock the full range of fischertechnik robotic kits and models plus spare parts, computer interfaces and control software. Learn about industrial automation and robotics with fischertechnik. See our website for the latest news and FREE software downloads. Don't forget to mention this ad for a 5% discount!

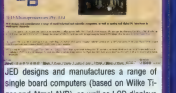
Procon Technology

Tel: (03) 9830 6288 Fax: (03) 9830 6481
WebLINK: procontechnology.com.au

International satellite TV reception in your home is now affordable. Send for your free info pack containing equipment catalog, satellite lists, etc or call for appointment to view. We can display all satellites from 76.5˚+ to 180˚.

Av-COMM Pty Ltd

Tel:(02) 9939 4377 Fax: (02) 9939 4376
WebLINK: avcomm.com.au



We're one of Australia's most innovative electronic equipment suppliers. For over 10 years we've served Australian industry with an extensive range of electronic components and equipment from the world's leading suppliers. We ensure our customers have the best selection and service.

Clarke & Severn Electronics

Tel: (02) 9482 1944 Fax: (02) 9482 1309
WebLINK: clarke.com.au

We aim to provide as much information as possible in our catalogue and via phone or email before you make your purchase. But in the event the product doesn't suit your needs, **don't worry!** Return it to us within **14 days** and we'll give you a full refund!

Jack O'Donnell,
Managing Director

THE ALTRONICS DIGITAL SALE!

For the month of May Altronics is offering great discounts on many products EXCLUSIVELY ONLINE! So get online with Altronics today and take advantage of shopping with us 24/7. Simply go to..

www.altronics.com.au

and click on the "Digital Sale" banner! Its that easy!

Check network cabling in seconds!

Checks 8 conductors plus shield for continuity, open/short and crosswired cabling. It can also check patch leads!

End of model number Specs over $30!

Features: • Auto/Manual mode • LED indicators • Suits 10Base-T, 10Base-2, RJ45, 258A, TIA 568A/568B and Token Ring • BNC to RJ45 Adaptor included • Soft carry case

$125
Normally $179
D 3010

Heatshrink Reducer

REDUCES HEATSHRINK TUBING IN SECONDS WITHOUT BURNING!

Also great for bending plastics. *Features:* Regulated temperature • Reliable piezo ignition • No direct flame

Keep one handy in the toolbox!

$29
Normally $36.50
T 2480

3 to 15V @ MASSIVE 25 AMPS!

Includes digital volt & amp meters for precise adjustment, overload & over temperature protection. Ideal for R & D, service benches etc. With fixed 13.8V output switch, great for automotive work! 25A current limited.

$299
Normally $349
M 8224

Pocket Size Blowtorch

STILL WORKS IN A HOWLING BREEZE!

Ideal for camping, hiking or even a cigarette lighter! Easy one hand operation with adjustable flame. One click piezo ignition. **AMAZING 12 MONTH WARRANTY!**

$14.95
Normally $19.50
T 2488

NEW compact 4 x AA battery charger!

Why spend a fortune on batteries? This charger will pay for itself in no time! Suits NiCad or NiMH. Approx 7 hour charge time.

$18.75
A 0285

BONUS DEAL! For just $10 extra, pick up 4 x AA 1300mAh batteries to go with your new charger. Valued at $22.40!

Replace 16 remotes with just ONE!

Coffee table covered in remotes again? Tired of juggling a handful of remotes just to watch a movie? The A 0990 combines the functions of up to 16 remotes into just one! Pre-programmed with hundreds of codes, setting up can be as easy as entering 4 numbers. Or use the simple learning function.

Features: • Touch sensitive backlit screen • Pre-programmed with 100's of remote codes • Learning mode • Custom device labels and layout • Macro • Optional windows software plus USB PC interface (A 0992 $69) available

$269
A 0990

Pre-programmed, ready to go!

Compact backlit DMM!

FEATURE PACKED! Includes continuity buzzer, thermocouple PLUS hold function! Small enough to fit right in your pocket! *Features:* • 19 ranges • Backlit display • K-Type temperature probe included • Temperature • DC Volts • AC Volts • Resistance • Continuity Tester • DC Current • Data Hold • Includes high quality test leads & shock-proof rubber holster

A perfect starter for the enthusiast, kit builder, note takers & user on a budget

$35
Normally $40.50
Q 1126

Hands free communication

Are you into motor sports ? Stuck in a noisy tractor cab all day? Manager of a theatre group or just flying a plane? Designed for comfort & hassle free service. It will reduce outside noise sources and allow you to communicate totally hands free. Fitted with super comfortable gel ear pads.

$195
Normally $235
C 9070 Green
C 9060 Black

"Why pay $250 or more like other brands"

Pro De-Soldering Station

NEW

WITH TEMPERATURE CONTROL & HIGH SPEED CONTINUOUS VACUUM ACTION! Completely effortless desoldering. Features a fully automatic trigger system that provides continuous suction as long as the trigger is pulled.

Desolders ≤ 14 pin IC socket in less than 30 seconds! Even on double sided PCB's!

$399
T 1260

120W Cordless Soldering Action!

This **120W** gas soldering iron offers **WIRE-FREE** convenience with a high capacity tank, giving you up to 4 hours soldering time per refill.

$95
Normally $109
T 2600Kit

$129
Normally $159
T 2601Kit

The T 2601 kit includes a T 2600 PLUS a protective carry case, wide range of tips & accessories including; cleaning sponge, solder dispenser, blow torch tip, air blower tip and hot knife cutter.

New improved model for even greater reliability!

70W Go Anywhere Soldering!

ONE HANDY CASE WITH THE LOT! The T 2592 gas soldering kit is crammed with goodies for the enthusiast on the go! Supplied in a super strong protective case. Kit contains:

New improved model for even greater reliability!

• T 2590 70W gas soldering iron • Safety stand • Cleaning sponge • Solder dispenser • Blow torch tip • Hot air blower tip • Hot knife cutter tip

$69.95
Normally $83.95
T 2592

Bulletproof 0-30V @ 5A Supply!

With dual digital displays for precision adjustment of both voltage and current settings. Perfect for any workbench or lab. *Features:* Up to 5A from 0-30V • Separate controls for voltage and current limiting • Fixed 12V & 5V output rails • Fully adjustable from 0 - 30V • Precision LCD voltage & current meters • Fully regulated • Short circuit & overload protection

Save over 25%!

$245
Normally $329
M 8205

Move data between PC's FAST!

Great for data backups or moving your data from home to office. Allows you to switch hard drives quickly and easily. *Features:* Power & HDD activity LED's, fan cooling. Also suits ZIPs, LS-120 etc.

Swap data with your mates!

$29.95
D 5500

INSPECT-A-GADGET© ILLUMINATED MAGNIFIER

Let "gadget" be your eyes! Identify those impossible to read miniature components, without straining your eyes. Great for stamp and coin collectors, model makers, seamstresses, jewellers etc. Easily clamps to the back of your desk, saving valuable work space!

$99
Normally $119
A 0970A

Features an ultra-bright Philips® triphosphor fluorescent tube for extra crisp,clear view! FOR NO EXTRA COST!

DELUXE Hi-Fi Headphones

Super comfortable with deep bass!

Featuring high quality diaphragm drivers with samarium cobalt magnets for superior sound reproduction. High quality flexible lead. Supplied with gold plated 3.5mm stereo plug & 6.5mm adaptor.

$25
Normally $29.95
C 9004

Multimedia Headset

With adjustable headband and in-line volume control. Ideal for internet phone or multimedia applications.

$19.95
Normally $29.95
C 9024

Jumbo Display LCR Digi-Meter

Fully featured LCR multimeter providing capacitance and inductance measurements! Also crammed in is a 10MHz frequency counter, diode & transistor check, temp measurement and logic tester. Audible safety buzzer to prevent use when leads are in incorrect sockets.

Features • AC/DC current • Continuity buzzer • Silicon rubber test leads and holster included • Inductance • Capacitance • Backlit display • Peak Min/Max

$135 Normally $159 **Q 1084**

Get some use out of that old telly!

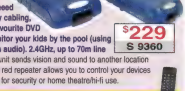
The perfect solution if you've got an old television with a new DVD player or gaming console, even a security camera! With built in 15dB antenna booster. Sets to VHF channel 3. **M 9236** plugpack to suit ($14.85)

$45 Normally $59 **S 9233**

Use your old TV with a new game console for the kids room!

Watch a movie in your bedroom!

AV Wireless transmitter with IR repeater. No need for any messy cabling, watch your favourite DVD in bed or monitor your kids by the pool (using a camera with audio). 2.4GHz, up to 70m line of sight. The unit sends vision and sound to another location whilst the infra red repeater allows you to control your devices remotely. Ideal for security or home theatre/hi-fi use.



$229 Normally $299 **S 9360**

***BONUS OFFER!* Purchase the S 9360 for $229 and receive the A 1008 remote control (valued at $62) for FREE!**

20MHz Dual Trace Oscilloscope

With the increasing complexity of electronic circuits a high quality oscilloscope is an absolute necessity for service techs & serious enthusiasts.

SAVE A HUGE $224.70!
THOUSANDS in use with labs, schools, universities etc **THROUGHOUT** Australia!

Features: Wide bandwidth and high sensitivity • Very low power consumption • High sensitivity X-Y mode • Z axis (intensity modulation) • Simultaneous display of original and magnified waveforms on each input • Front panel electrical trace rotator • Regulated power supply circuit for accuracy • TV video sync • High frequency rejection filter in the triggering circuit

$649 Normally $799 **Q 0150**

Pro Iroda® Blow Torch

This superb blow torch is ideal for model making, heatshrinking, brazing, silver soldering and more!

Push-on, push-off operation so you don't have to hold the trigger down! Piezo ignition ensures a reliable start every time.

Features: Flame temperature can reach up to a roasting 1300° C • Huge refillable gas reservoir • Wind proof jet flame • Adjustable air supply • Handy bench stand • 12 month warranty.

$49 Normally $73.50 **T 2495**

Keyring Laser Pointer!

Laser pointers are amazingly useful. Used around the world in lectures, building sites and guided tours. Intense beam travels up to 50m

$16 Normally $20.95 **A 0205**

Maximum Permitted Power Output 1mW

3 FREE Spare Batteries (Total value $4.50) Included with every A 0205!

Brymen® Datalogging DMM

Autoranging & Optical RS232 Interface

The Brymen® BM202 digital multimeter is packed with value. It has features usually found in meters 2 or 3 times the price! Datalogging feature is great for those monitoring battery charge rates, graphing temperature variations etc (software supplied with Q 1082 interface kit).

Features: Auto ranging • EF mains detect • Data hold • Temperature • AC/DC voltage • AC/DC current • Resistance • Diode check & buzzer • Frequency

FREE! Q 1082 RS232 Optical PC Interface to suit, valued at $26.25!

$125 Normally $160 **Q 1080**

Sounds fantastic! Looks amazing!

(SC Nov-Dec '01) **LOOKS SO GOOD YOUR FRIENDS WON'T BELIEVE YOU BUILT IT YOURSELF!**

Rated at 100W RMS per channel this amplifier produces almost unmeasurable low levels of distortion.

Features: LED bargraph meters • Gold plated speaker terminals • 19" Rack or desk mount • Screened and pre-punched chassis for a professional finish • CD, Tuner, DVD, Tape & Aux inputs • Supplied with 19"rack mount kit.

$649 Normally $699 **K 5155**

Premium grade cable. Buy a roll and save a fortune!

"Whopper" Wire

Flat style oxygen free cable for superior sound & low noise. 102/0.12 strand. 50m roll.

95c/m Normally $1.60/m **W 2140**

FIG "8" Cable

Heavy duty 24/0.20 Red/Black Only 30m roll.

50c/m Normally 60c/m **W 2120**

Cat 5e & 6 Cable

HUGE 305m pull box for easy installation and neat storage.

Prices are PER BOX

Data Cable	Normally	NOW
W 2760 Cat 5e	75c/m	**50**c/m
W 2764 Cat 6	$1.62/m	**$1**/m

Buy a box and save a heap!

Digital Hygrometer & Thermometer

Ideal for fish tanks, home brew kits, cellars!

Features: • Large LCD • 12/24 hour clock • Internal/External temp sensor • Humidity • Backlighting • 4 mode temp alert (audible alarm), within range, out of range, high and low temp • -50°C to +70°C • Max/Min memory • Sensor waterproof to 3m

$40 Normally $47.50 **A 0156**

20 Watt Soldering Iron

1000's now in use, our most popular model ever!

JUST THE SHOT FOR THE BUDDING ENTHUSIAST OR HOME HANDYMAN!

With 20 Watts of power, high efficiency heating element. 370°C fixed temp.

$34 **T 2420**

PERFECT FOR THE ENTHUSIAST!

FREE ACCESSORIES!

Receive a T 1100 200g solder roll and T 1310 Iron stand, valued at over $24, **FREE!** with every T 2420!

BE QUICK! Limited to First 50 Callers Only!

60W Professional Soldering Station

With tip temperature display and quality Japanese ceramic heating element for rapid heat recovery.

FREE* Purchase the T 2438 & receive a free T 2439 solder holder and a 1kg roll of T 1115 solder (as shown) valued @ $40.55. At no extra charge!

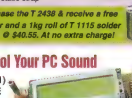
Features: • Dual mode LED temp display • Superior ceramic heating element • Zero-volt switching • Light weight ergonomic mini handle • Temp range 200 - 500°C • Temp lock facility • Iron stand can be mounted either side • 4mm earthing point for anti-static strap

$250 **T 2438**

Remote Control Your PC Sound

(SC Sept - Nov '01) GREAT FOR ANYONE WITH AN MP3 COLLECTION!

Remote control your PC's MP3 songs and play lists with this great kit. Ideal for cuing up a whole nights party music! Remote can provide all the functions of your average CD player.



$89.95 **K 2750**

***BONUS!* Purchase the K 2750 for $89.95 and receive the A 1013 remote control (valued at $36) for FREE!**

Punchdown Tool

Why pay through the nose for a genuine brand name tool?

$59 **T 1603**

SLA Batteries

BARGAINS!

Premium grade long life, sealed lead acid batteries.

1000's sold to security company's across Australia!

		Normally	1up	2up
S 5075B	1.3Ah	$24.50	**$20**ea	**$15**ea
S 5080	3.0Ah	$32.50	**$25**ea	**$20**ea
S 5090B	7.2Ah	$39.50	**$30**ea	**$25**ea

Amazing price! Amazing features!

We couldn't cram any more features into this meter if we tried! Get in quick for these. ***Features:*** • 19 ranges • DC Volts • AC Volts to 600V • Resistance • DC Current • Data Hold • Includes high quality test leads.

Ideal for the budding enthusiast!

$15 Normally $19.95 **Q 1121**

■ EXPRESS
Overnight Delivery!*

■ NO RISK
14 day money back guarantee†

ALTRONICS

Mains power from a 12V car battery!
ANYWHERE! ANYTIME!

Inverters are great for anywhere a remote power solution is required. The Powerhouse range comes in many different sizes suitable for different applications eg: 130W suits laptops etc.. while 720W suits power tools and small pumps. Ideal for tradesman, farmers, service vans, camping etc. All feature protection from incorrect polarity, over load, over temperature, short circuit.

130W Inverter 240V Modified Sine Wave 400W surge rated. With cigarette lighter plug

$99 Normally $109 **M 6102**

380W Inverter 240V Modified Sine Wave

CAN YOU BELIEVE IT? UP TO 1200W SURGE IN A VERY COMPACT UNIT!

Ideal for campers, RVs, 4WD, boats, trucks, farmers etc..

$169 Normally $219 **M 8116**

720W Inverter 240V Modified Sine Wave

Ideal for anyone who needs to operate their tools away from a 240V outlet! 2000W surge rated.

GREAT FOR TRADES PEOPLE!

$319 Normally $389 **M 8132**

See in the dark camera pack!

SUBMERSIBLE DOWN TO 30m!
B&W Sealed Infra Red Camera. Compact CCD camera ideal for use outdoors. Includes handy swivel bracket. Great for aquaculturists, aquariums, fishing-cams... and much more! **M 9236** plugpack to suit $14.85

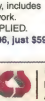
FREE! P 6710 20 metre connection lead (power+video+ audio). Valued at $39.00

$209 **S 9080S**

Get portable with your sound!

(SC February '03) Ideal as a portable sound solution for school assemblies, public speakers, sporting venues, meeting halls etc.

Features • Portable 12V battery powered unit • 33W RMS into 4Ω • 2 combination 3 pin XLR/6.35mm mic inputs • 6.35mm guitar/aux input • Stereo RCA line inputs • Short form version only, includes PCB's, components and metalwork. WOODEN CABINET NOT SUPPLIED. **Recommended speaker C 2006, just $59!**



$179.95 **K 5360**

NEW

Ultrasonic Clean, Just Add Water!

This little gem cleans the tiniest delicate items without the risk of damage. Uses just a little water and the ultrasonic waves it generates for the perfect clean!

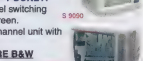
$175 Normally $199 **A 0102**

IDEAL MOTHERS DAY GIFT
Great way to easily clean up precious jewellery without nasty solvents or abrasives!

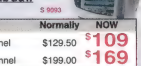
Catch Thieves Red Handed!

DON'T LET THIEVES AND VANDALS HIT YOU IN THE HIP POCKET!
S 9090 is a 2 channel switching unit with a 6 inch screen.
S 9093 is a single channel unit with a 10" screen.
BOTH MODELS ARE B&W

S 9090



S 9093

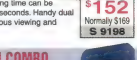


	Normally	NOW
S 9090 6" 2 Channel	$129.50	$109
S 9093 10" 1 Channel	$199.00	$169

4 Way AV Camera Switcher

Suits B&W or Colour cameras!

This versatile switcher will switch up to 4 camera inputs with audio. Each channel can be viewed sequentially and switching time can be adjusted between 1-15 seconds. Handy dual outputs allow simultaneous viewing and recording!



$152 Normally $169 **S 9198**

STROBE/SIREN COMBO

Combination siren and strobe in a single weatherproof housing. 10-14V. Features separate input for siren and strobe.

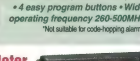
$25 Normally $30.40 **S 5415**

Save time, space AND money!

UHF Remote Control

This learning remote can be used to combine several remotes or replace an old broken one. Ideal for garage doors, car or bike alarms, home alarm, etc.

** 4 easy program buttons • Wide operating frequency 260-500MHz*
**Not suitable for code-hopping alarms*



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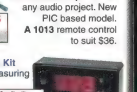

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VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

The HMV C43B console radio

Generally considered a "step-up" from mantel radios, console receivers enjoyed an extended period of popularity from the 1930s to the early 1950s. Typical of the era was the HMV C43B console, a 5-valve receiver with an impressive cabinet and performance to match.

At the height of its popularity, a console receiver was usually the focus for household entertainment, just as DVD players and home-theatre equipment are today. Their reign ended during the late 1940s and early 1950s when they evolved into the popular radiogram of the era.

To cater for the demand, domestic receiver manufacturers developed a range of impressive console radios. Consoles always sounded more impressive in terms of volume and audio quality compared to the table and mantel sets of the era. The reasons for this weren't hard to find – they had adequate baffling for the speakers mounted in them and speaker sizes varied from 6-inch to 12-inch types.

By contrast, mantel sets had to make do with speakers ranging from three inches to eight inches in size. What's more, their baffling was either inadequate or there was no baffling at all.

The HMV C43B

HMV had many fine pieces of furniture produced for them, into which they fitted quality receivers. The C43B is a typical example. The "C" in the model number means it is a 5-valve dual-wave receiver; the "4" means it is a horizontal console (whatever that meant); the "3" means it is an AC-powered receiver; and the "B" indicates that it is a second issue model of this type.

Table 1 shows the model number code used by HMV and will help readers to identify other HMV models.

The C43B console receiver described here belongs to a fellow vintage radio club member and is one of Jim's more interesting radios. The set itself is quite attractive and given the right setting, would look quite impressive in the lounge room.

As can be seen in the photos, the dial sits horizontally along the top front edge of the cabinet (perhaps that is what is meant by "horizontal" in the identification table). The dial doesn't impress me as much as some of the early HMV dials but it is still quite functional, It's also simpler than some of the earlier units, so it is less likely to give trouble with wear over an extended period.

This rear view shows the C43B receiver chassis mounted in the cabinet. Note the large metal brackets at either end.

Information sheet

A sheet of paper glued to an inside panel of the cabinet details the dial drive system and indicates the valve type used at each location. This valve location guide is handy for ensuring that the valves are correctly replaced in their respective sockets after they have been removed for testing.

It was not an uncommon practice in the 1930s, 1940s and 1950s for set owners to remove all the valves when the radio refused to operate or had some other annoying fault. They would then take them to their local radio serviceman and ask him to test them. The serviceman often did this on his emission type valve tester as a free service to the customer.

Any valves that showed "replace" on the meter were considered faulty

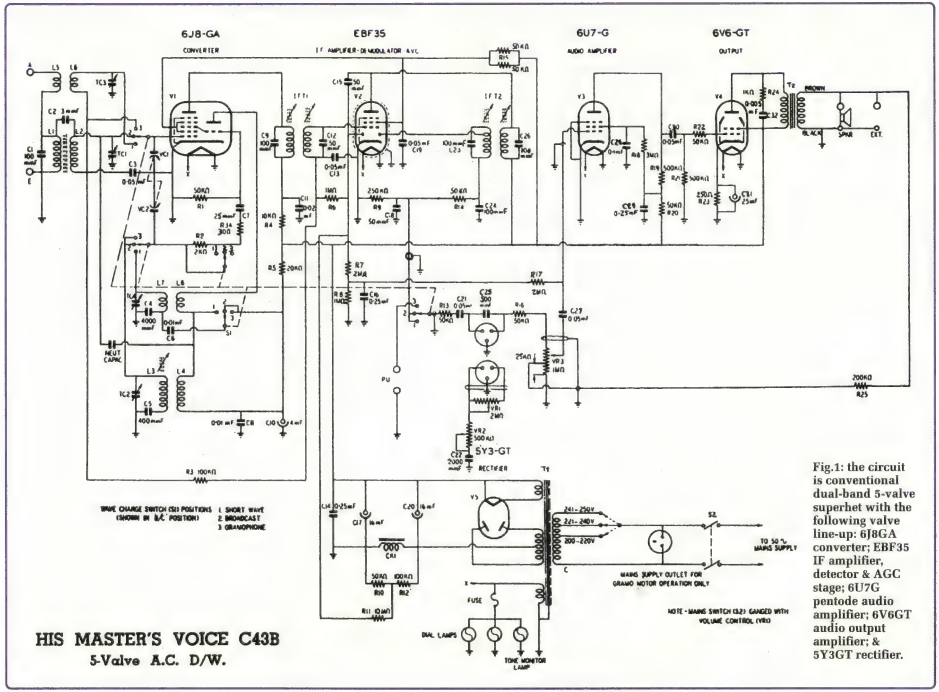

Fig.1: the circuit is conventional dual-band 5-valve superhet with the following valve line-up: 6J8GA converter; EBF35 IF amplifier, detector & AGC stage; 6U7G pentode audio amplifier; 6V6GT audio output amplifier; & 5Y3GT rectifier.

It may be a little plain from the front but the cabinet is still an impressive piece of furniture.

The large oval-shaped loudspeaker is properly baffled by the cabinet, which contributes to the audio quality.

and the set's owner would usually buy a new valve in the hope that that would fix the problem. I wonder how many valves were replaced just because the tester said "replace", when in reality the valves still had quite a bit of life left in them for the job they had to do?

On returning home, an owner would then put the valves back into the set and turn it on. Often, of course, it didn't work and sometimes smoke even erupted from the set.

Why? Many owners did not understand the significance of valve type numbers and he (she) may well have installed a 6V6G in a 5Y3G socket, or been responsible for some other equally disastrous substitution. Valves often survived this rugged treatment but many didn't. Hence, you can see the value of having the type numbers either on a sheet, as this set does, or painted onto the chassis alongside each valve socket.

An episode like this often meant that the radio had to be taken to the serviceman to rectify the damage that had occurred.

In short, it pays to be careful when replacing valves, to ensure that you don't plug the wrong valve into the wrong socket. If in doubt, ask someone with more experience.

The tone controls

The tone controls on this set are on a separate sub-assembly that's attached to the front panel of the receiver. They connect to the main chassis via a plug and socket combination.

The receiver will operate with the tone controls disconnected, although it will lack bass performance. That's because, with the tone controls disconnected, there's just a 500pF coupling capacitor in the audio chain. Fig.1 shows the tone control circuit (VR1, VR2 & C22) and shows how it is attached to the main circuit.

Removing the chassis

The chassis is easy to remove and simply involves removing the bolts that fasten the chassis to the mounting shelf, then removing the knobs and disconnecting the loudspeaker and tone controls. The chassis can then be removed and, thanks to the large "roll-over" brackets located at either end, stood on its end for service.

Circuit details

The circuit is quite conventional – it has a 6J8GA converter; an EBF35 IF amplifier, detector and AGC stage; a 6U7G pentode audio amplifier; and a 6V6GT audio output amplifier. The power rectifier is the common 5Y3GT. The set is dual-wave, covering 540-1600kHz and 5.9-18.1MHz, and it also features a pickup input ("PU") so that records can be played through the audio amplifier stage.

The converter stage has AGC voltage applied to it on both the broadcast and shortwave bands. On the broadcast band, the converter is neutralised and HMV was one of the few manufacturers that took the trouble to do this (neutralisation results in im-

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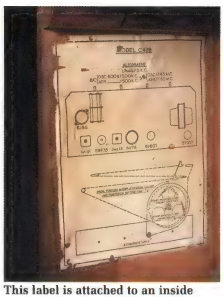
HMV Model Number Code		
Parameter	**Code**	**Meaning**
Performance	A	4-valve broadcast band receiver
	B	5-valve broadcast band receiver
	C	5-valve dual-wave receiver
	D	5-valve dual-wave non-auto radiogram
	E	5-valve dual-wave auto radiogram
	F	Electrogram
	G	Electric record player
	H	Spring record player
	J	Spring acoustic player
	K	FM tuner
	L	FM/AM broadcast-band receiver
	M	FM/AM dual-wave receiver
	N	Extension speaker
	P	4-valve dual-wave receiver
Type of cabinet	1	Bakelite mantel
	2	Bakelite table
	3	Wooden table
	4	Horizontal console
	5	Vertical console
	6	Portable
	7	Metal case
Power supply	1	Dry battery
	2	DC
	3	AC
	4	DC/AC
	5	6V vibrator
	6	12V vibrator
Styling	A	First issue
	B	Second issue, etc

HMV audio equipment was given a 4-digit model number, which specified the performance, type of cabinet, power supply and styling. For example, the HMV 5-valve portable was coded B61A, the 1948 5-valve table dual-wave receiver (formerly 888) was a C33A and the 1949 5-valve bakelite table dual-wave receiver was a C23A.



This label is attached to an inside panel and shows the dial stringing arrangement and the valve positions.

proved performance and less radiation of the oscillator signal from the antenna system).

On shortwave, padder feedback capacitor (C6) is used to ensure that the converter oscillates reliably across the entire tuning range. An unusual feature here is the inclusion of a 2kΩ resistor (R2) in the grid lead circuit of the local oscillator for the broadcast band. Obviously, the oscillator was quite "lively" on the broadcast band so this resistor was included to reduce its activity and prevent spurious harmonics from being generated.

The aerial/antenna input circuit is one that HMV commonly used. Note that the shortwave primary winding (L5) is in series with the broadcast band coil (L1) primary. On the broadcast band, the inductance of L5 is quite low and it actually acts as a small loading coil in series with the antenna. So, for all practical purposes, the broadcast coil is not affected by the shortwave coil.

The broadcast coil primary is tuned by L1 and C1 so that it resonates at a frequency just below the broadcast band. This is done to get the best performance on the lower frequency stations. C2 is a "top-coupling" capacitor and its inclusion ensures good performance at the high-frequency end of the dial.

On shortwave, L1 acts as a radio frequency (RF) choke and prevents L5 from operating effectively. However, while L1 acts as an RF choke, C1 has very little reactive effect at shortwave and so the bottom of the shortwave winding is effectively connected to earth. This saves the use of a switch section and is quite effective.

The intermediate frequency (IF) amplifier is quite conventional, operating on 457.5kHz. As shown, the detector diode takes its signal from a tap on the secondary of the second IF transformer. This gives higher selectivity as opposed to extracting signal from the top of the winding.

The signal for the AGC diode is taken from the plate of the IF amplifier valve, where the signal is stronger but the selectivity is reduced. This method helps to smooth the operation of the AGC system and ensures that it starts to work before the signal is fully tuned in, thereby preventing momentary "blasting" before the AGC becomes fully operational.

The AGC is delayed by the bias supplied through R11 (at the bottom of Fig.1). Note that about a third of the AGC voltage is applied via R17 to the 6U7G audio valve! This technique is rather unusual but was often favoured by HMV in particular.

By doing this, the peak audio volume will remain almost constant for quite wide variations in signal strength. This usually obviates the need to alter the volume control setting when tuning from a strong to a weak station and vice-versa. However, it does increase the noise between stations in some circumstances.

Audio amplifier

The audio amplifier is a conventional high-quality, high-gain design with audio AGC as mentioned. There is voice coil negative feedback to the first stage via a tap on the volume control. The audio quality is quite good, being noticeably better than the average mantel receiver.

The power supply has an unusual feature in that the filter choke has been placed in the negative lead. The advantage of this is that the voltage between the winding and the frame is quite low. The delay bias for the AGC system is obtained by a voltage divider across this choke.

Note that a third of the voltage across the choke is used for this bias. This is dropped by another two thirds by a voltage divider consisting of R11, R7 and R8.

Most stages employ quite good decoupling, which accounts for the set's good stability and performance. However, this receiver, like many others, has minimal decoupling of the audio output stage from the IF stage and audio preamplifier. That said, the set has sufficient filtering to remove the IF signal from the audio circuit.

This is necessary to ensure that the audio stages don't act as IF amplifiers, with the possibility of feeding back into the IF amplifier. Inadequate filtering in this area has led to a number of receivers being unstable in some circumstances.

As with most, if not all, HMV receivers of the late 1930s to early 1950s, the wiring is very neat and the set gives the impression of being a quality item (which it is).

Restoration

As with most receivers, there are a few key components that should be replaced almost without question. These include the AGC bypasses and audio coupling capacitors (unless you can test them under real life conditions with high voltages and when they are quite warm). Note that a normal multimeter (set to an ohms range) rarely gives a true picture when it comes to testing capacitors.

Only a few components needed replacement in this receiver. In addition, it is also a good idea to check the shielded wires in sets of this era. In some sets, the rubber insulation inside the shield perishes and often goes "gooey" – sometimes becoming conductive in the process. When this happens, it is necessary to replace it with new shielded cable.

Despite the set's age, Jim found that the valves were all in good condition. What's more, it required no attention to the alignment. The cabinet also required very little attention, having been well looked after by its previous owner. This is one set that had been kept inside, rather than stored in a damp and dusty shed.

Summary

This set is one of many HMV receivers that look good and perform well. It's only real drawback is having the horizontal dial on the top of the cabinet, as it's always possible for someone to put something on top of it and cause damage. What's more, the operator still has to reach down the front of the set to tune it, although the arrangement does make it easy to see the stations.

That said, if it had been set down a little from the top and at an angle (like most of its contemporaries), the set would have looked better. As it stands, the set looks a little bland when viewed from the front.

In spite of this minor criticism, the HMV C43B is a good performer and is well worthwhile having in your collection. **SC**

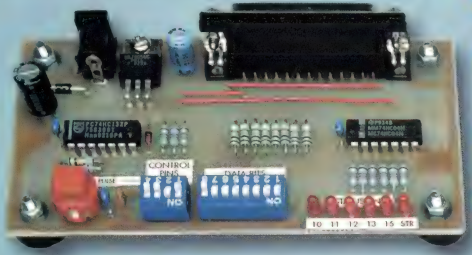
Photo Gallery: 1940 Tasma Model 710 5-Valve Radio

Manufactured by Thom & Smith Pty Ltd in 1940, this Tasma Model 710 from was a compact 5-valve dual-wave mantel set. It featured an unusual "rust-stained" white bakelite cabinet and this was manufactured using a process that ensured no two cabinets were ever like.

Band switching was controlled by a central winged knob, although this became the tone control on broadcast band only models. The valve line-up was as follows: 6J8G frequency converter, 6U7G IF amplifier, 6G8G audio amplifier & detector, 6V6G audio output and 5Y3G rectifier.

This particular unit was been fully restored by its owner, Maxwell Johnson, Kingston, Tasmania. (Photo: Ross Johnson).

The LPT Simulator will take you next to no time to build. Note that the final version differs slightly from this prototype.



- Ideal for trouble-shooting
- Lets you manipulate the data & control lines
- Has 6 LEDs for status monitoring
- Low cost & easy to assemble

Printer port hardware simulator

Do you need to test printers or other items of equipment that connect to a PC's parallel printer port? This low-cost, easy-to-build circuit will let you test them quickly, without the need for a PC or test software.

By JIM ROWE

BASICALLY, THIS DEVICE is a simple hardware simulator. It allows you to manipulate the port's data and control lines, monitor the status lines and even send the printer (or other equipment) a 'strobe' pulse.

The idea for the Printer Port Simulator came about while we was developing our Windows-based EPROM Programmer. We struck a rather tricky timing fault and subsequently wasted a fair bit of time trying to work out whether it was due to a problem with the hardware or a bug in the software.

The same sort of problem can occur when you're trying to track down a fault in other kinds of PC-driven equipment, of course. It can even happen when you're getting weird problems with a printer.

We ended up resolving our particular problem by lashing up this Printer Port Simulator. This allowed us to send basic control signals to the EPROM programmer and monitor its status lines, without having to worry about software debugging until later. It proved to be very effective and enabled us to track down the cause of the timing error.

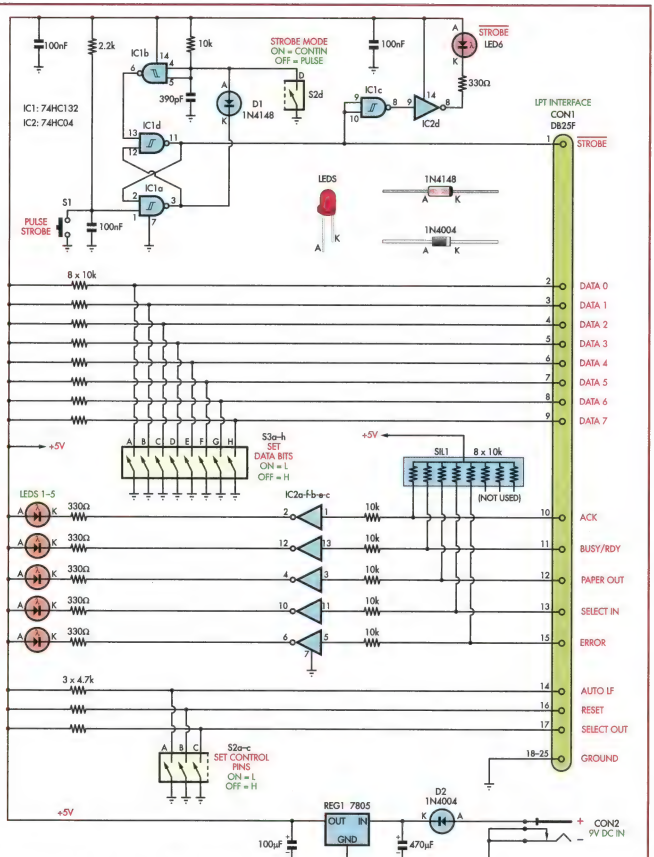
Later on, we realised that our Printer Port Simulator could also be used as a general troubleshooting tool to solve similar problems. So here it is and there's really very little in it – just two cheap ICs, a +5V regulator, a couple of DIP switches to set up the data and control bit lines, six LEDs for status indication, a pushbutton to produce strobe pulses and a handful of other components.

It all fits on a small PC board measuring 113 x 61mm and runs from a 9V DC plugpack. The maximum current drain with all LEDs on is just 58mA.

How it works

Refer now to Fig.1 for the circuit details. The simulated "port interface" is provided via CON1, which duplicates the DB25 female connector used to provide the standard printer port on a PC.

Pins 2-9 are used for the main data bus (DATA 0-7) to the printer. These pins are connected to a very simple data input circuit which uses eight 10kΩ pullup resistors and an 8-way DIP switch (S3). Each pole of S3 is simply connected between one of the data lines and ground – when a switch



PRINTER PORT SIMULATOR

Fig.1: the circuit is straightforward – just some DIP switches to set the data bits and control pins, a flipflop to generate the strobe pulse and some indicator LEDs to monitor the status lines.

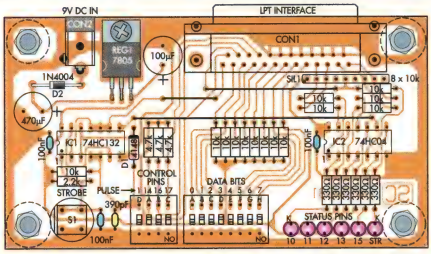


Fig.2: install the parts on the PC board as shown here, taking particular care to orientate the DIP switches correctly. In addition, switch S1 must be installed with its flat body surface to the left.

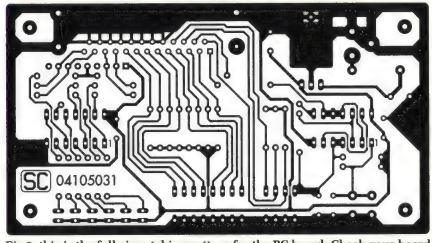


Fig.3: this is the full-size etching pattern for the PC board. Check your board carefully before installing any of the parts.

is closed, that line is pulled to ground.

Conversely, when a switch is opened, that data line is pulled to logic high (ie, +5V) by the pullup resistor. As a result, the DIP switch can be used to feed any desired extended-ASCII data bit combination to the printer (or other device) – ie, from 00 to FF hex.

Similarly, 4-way DIP switch S2 is used to set any desired combination of bits on three of the four control lines of the port: ie, pin 14 (Auto LF), pin 16 (Reset) and pin 17 (Select Out). Note that, in this case, the pullup resistors have a value of 4.7kΩ rather than 10kΩ.

The remaining printer control line connects to pin 1 of the DB25 connector. This line is normally used to send the negative-going "strobe" pulse to the printer, to begin printing each character. For correct printer operation, each strobe pulse should be a single clean pulse about 1-2µs long.

In the simulator, we generate this pulse each time switch S1 is pressed. This is done by using a simple one-shot circuit formed from three gates in IC1, a 74HC132 quad Schmitt NAND device. NAND gates IC1a & IC1d are connected as an RS (reset/set) flipflop which is triggered by pressing S1. The associated 2.2kΩ pullup resistor and 100nF shunt capacitor form a simple "debounce" circuit.

Diode D1 and NAND gate IC1b are used to convert the flipflop into a one-shot multivibrator. This works as follows: normally, pin 1 of IC1a is held high by the 2.2kΩ pullup resistor. This means that pin 3 is normally low and so pin 11 (the strobe-bar output) is normally held high.

Because pin 3 is low, D1 is forward biased and holds the voltage at the inputs of IC1b low as well. As a result, the output of IC1b (pin 6) is held high, as is the pin 13 input of IC1d.

Now when S1 is pressed, the 100nF capacitor is discharged and so a logic low is applied to pin 1 of IC1a. As a result, the flipflop is triggered into switching states – ie, pin 3 goes high and pin 11 goes low. This marks the start of the strobe-bar pulse.

When pin 3 goes high, it removes the forward bias on D1 and so it can no longer pull pins 4 & 5 low. As a result, the associated 390pF capacitor begins charging via a 10kΩ resistor.

After about 2µs, the voltage on pins 4 & 5 rises high enough to switch IC1b. When that happens, pin 6 of IC1b goes low and because this pin is connected to pin 13 of IC1d, this triggers the flipflop into switching state again. As a result, pin 3 switches low and pin 11 switches high, bringing the strobe-bar pulse to an end.

Note that this all takes place only if S2d is open. That's because if S2d is closed, it holds both inputs of IC1b low permanently and so prevents IC1b from resetting the flipflop.

Basically, S2d allows you either to produce strobe-bar pulses using S1 (when S2d is open) or to hold the strobe line down continuously after pressing S1. This second mode is handy for troubleshooting.

Status LEDs

Most of the remaining circuitry in the simulator is used to drive LEDs 1-5. These are used to monitor the "printer status" lines of the parallel port – Acknowledge (pin 10), Busy/Ready-bar (pin 11), Paper Out (pin 12), Select In (pin 13) and Error (pin 15).

As shown in Fig.1, the LEDs are driven by inverters IC2a, IC2b, IC2c, IC2e & IC2f, all part of a 74HC04 hex inverter. Five of the 10kΩ resistors in SIL1 are used as pullups on the input lines, to prevent them from "floating" at an intermediate level when the simulator is not connected to a printer or other equipment. The series 10kΩ resistors are used for additional protection against electrostatic charge damage to the gate inputs.

IC1c and IC2d are used to drive LED6, which indicates the status of

the strobe-bar line. This LED is illuminated when the line is low (because this line is nominally active low) and is off when it's high.

Of course, the narrow nature of the strobe-bar pulse means that in pulse mode (S2d open), the LED glows so briefly it's not easy to see. LED6 is therefore used mainly to verify the quiescent level on the line and of course, the level in non-pulse mode (S2d closed).

Power supply

The only part of the circuit we haven't talked about yet is the power supply. This is very simple, consisting purely of a 7805 regulator (REG1) to produce a stable +5V rail from an unregulated 9V DC plugpack. Series diode D2 provides reverse polarity protection, while the 470µF and 100µF electrolytic capacitors provide filtering and stability.

Construction

Everything fits on a single-sided PC board measuring 113 x 61mm and coded 04105031. This is possible because we've used board-mounting components for DB25 socket CON1, DC input connector CON2 and pushbutton switch S1. In fact, the board is designed to be freestanding, supported by four small screw-on rubber feet (one on each corner).

Fig.2 shows the parts layout on the PC board. As can be seen, the display LEDs, DIP switches and pushbutton switch S1 are all arranged along the front of the board, for ease of use. Conversely, the two connectors are at the rear, to allow convenient cable connections.

The assembly should take you next to no time. Begin by fitting the two connectors, then the three wire links, the DIP switches and pushbutton switch S1. Note that the DIP switches must all be fitted with their "ON" side towards the front of the board – they may look upside down but this gives the correct switching sense.

Take particular care when installing switch S1. It must be installed with its flat body surface to the left – ie, one parallel pair of pins to the front and the other parallel pair to the back. If it's installed incorrectly, you'll get a permanent short across the 100nF capacitor and the switch won't work.

Next, install the resistors and the SIL resistor array. That done, you can fit the small capacitors and the electrolytics. Be sure to fit the latter with the correct polarity, as shown on Fig.2.

The semiconductors can now all be installed. These include the diodes, LEDs, regulator and ICs. As usual, take care with the polarity of each of these. Note that all six LEDs are fitted with their cathode "flat" side towards the rear of the PC board.

Regulator REG1 is mounted horizontally on the top of the board, with its three leads bent downwards at 90°, 5mm away from the body. Its metal tab is then secured to the board using an M3 x 6mm machine screw and a nut underneath. This also provides a small amount of heatsinking, as there's a rectangle of copper underneath as well (there's no need for a separate heatsink).

Your simulator board should now be complete, apart from fitting the four rubber feet. These are fitted using M3 x 9mm machine screws passing up from underneath and fitted with nuts on the top.

Check-out time

It's very easy to give the completed simulator a quick check-out. First, set DIP switches S2a-S2d to their OFF positions (ie, towards the rear) and connect a 9V DC plugpack to CON2. That done, apply power and check that the first five LEDs light. If they do, use your DMM to check the supply voltage at pin 14 of either IC1 & IC2 – it should be close to 5.00V.

At this stage, LED6 should be off. Now set S2d (the leftmost DIP switch in S2, nearest the pushbutton) to ON and press S1. LED6 should now light and stay that way, unless S2d is turned OFF again.

If all of the above happens as expected, your simulator is working correctly and ready for use. If not, turn off the power and look for faulty solder joints and components fitted with reversed polarity. These are the only likely causes of problems with such a simple project. **SC**

Parts List

1 PC board, code 04105031, 113 x 61mm
1 PC-mount pushbutton switch (S1)
1 4-way DIP switch (S2)
1 8-way DIP switch (S3)
1 DB25 female connector, PC-mount (CON1)
1 2.5mm DC socket, PC-mount (CON2)
1 9V 150mA DC plugpack
4 small rubber feet
4 M3 x 9mm machine screws with hex nuts
1 M3 x 6mm machine screw with hex nut

Semiconductors
1 74HC132 quad Schmitt NAND gate (IC1)
1 74HC04 hex inverter (IC2)
1 7805 +5V regulator (REG1)
6 3mm red LEDs
1 1N4148 silicon diode (D1)
1 1N4004 1A silicon diode (D2)

Capacitors
1 470µF 16V PC-mount electrolytic
1 100µF 16V PC-mount electrolytic
3 100nF monolithic or ceramic
1 390pF ceramic

Resistors (0.25W, 1%)
14 10kΩ 1 2.2kΩ
3 4.7kΩ 6 330Ω
1 8 x 10kΩ SIL array

Table 1: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
14	10kΩ	brown black orange brown	brown black black red brown
3	4.7kΩ	yellow violet red brown	yellow violet black brown brown
1	2.2kΩ	red red red brown	red red black brown brown
6	330Ω	orange orange brown brown	orange orange black black brown

Spinning along with PICAXE

Hopefully you've been following our previous "PICAXE-08" articles and by now have tested, tweaked, tortured and tamed diverse circuits.

by Stan Swan

Although these initial "PICNIK box" ideas were based around a solderless protoboard, there's naturally nothing sacred about that!

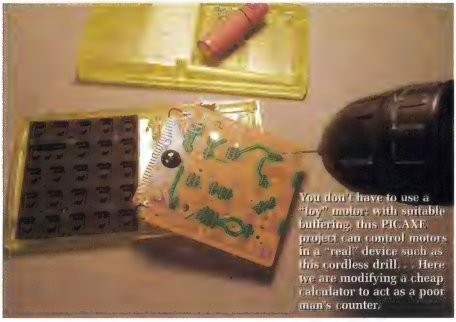
In fact, reader email feedback shows boundless "down under" prototyping initiative at work, such as just a 16-pin DIP IC socket wired as a minimal test bed. A "seamail" even detailed an old salt's "08" control of a diesel generator (using the READADC feature to monitor output voltage) rustled up while cruising off Tasmania. Did he get a controller dropped by seagull?

Perhaps the appeal of PICAXE circuits relates to just such an approach, since many of the "usual" electronic components can be organised under software rather than silicon and copper hardware. The "08" is certainly shaping up as the little controller that could ...

Supply voltage

As remarked in April (and now confirmed by Revolution Education), some users have found a 6V supply too high. Unreliable programming, or even "bootstrap" wiping, may occur at this voltage, particularly (it seems) with late 1990's RS-232/USB transition PCs. (However, all my programming, using a full 6V and an AMD 475MHz notebook, has had no problems.)

Naturally 4 AA cells will have more energy on tap to keep your circuit running longer, but it appears that 5V should now be the maximum supply. Several techniques to achieve this may be used: use a dummy shorting cell and so run off a 3 cell (4.5V) supply; drop 0.7V multiples with a series-connected silicon diode or two; or even use Nicad/NiMH cells (4 x 1.2V = 4.8V).



You don't have to use a "toy" motor; with suitable buffering, this PICAXE project can control motors in a "real" device such as this cordless drill. . . Here we are modifying a cheap calculator to act as a poor man's counter.

Outputs

Outputs so far have just driven LEDs or made sounds but could even be used to pull in sensitive relays.

When more power hungry loads are driven, the limited PICAXE output current (~20mA) needs buffering if the IC is not to be overwhelmed. For modest loads, drawing just a few 100mA, a simple "electronic relay" bipolar transistor will handle this job nicely. Should you have more ambitious applications in mind, drawing considerable current, then respect all those boring issues relating to separate power supplies, heat dissipation and possibly substantial "back-EMF" and stalling currents.

For such uses, the L293D H-bridge motor driver IC is suggested, since it's capable of forward-reverse-stop twin motor control (to 600mA per channel) and comes with inbuilt spike protecting diodes – all for under about $10.

Revolution Education sell the L293D pre mounted on the AXE023 motor driver board, that even includes a PICAXE-08 socket.

To ease you into motor control however, this month's main circuit uses a very efficient DC "solar motor", typically drawing just 30mA at 3V. Small hobby motors often draw hundreds of milliamps – these so called solar mo-

tors are normally intended for sun powered photovoltaic projects. Just 30mA – this motor could almost be driven directly from a PICAXE output . . . but let's not push our luck!

Almost any handy small signal NPN transistor can be used to achieve buffering, although the base resistor value may need changing if types other than a BC547 (capable of handling more current) are used.

The usual DC motor "hash" is taken care of by a 100nF capacitor directly across the motor terminals and a reverse-connected silicon diode tames any motor "back-EMF".

A small paper flag glued suitably to the shaft indicates rotation and is safe enough should your fingers come too close while spinning.

The program

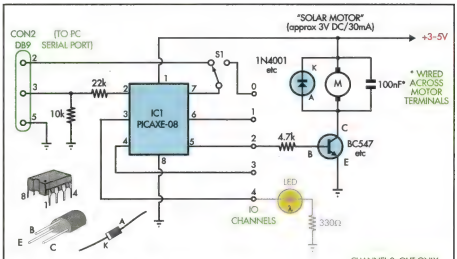
The program is again quite self explanatory and simply organises an endless but entertaining "speedup/slowdown" procedure. Try doing this with a 555! The initial "kickstart" helps overcome motor mechanical friction, although a drop of CRC lubricant ("oilware"?) on the bushings may be just as helpful.

Reference to previous month's LDR/NTC ADC sensor circuits could stimulate you to modify and enhance this program so motor speeds could now be light or temperature-controlled.

Aha – how about a small cooling fan that sped up when the air temperature rose? Of course, more powerful small motors can be used but you'll need to switch to a beefier transistor such as the TIP41C or BD437 along with a modified base resistor for that.

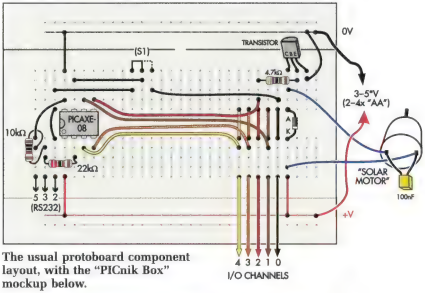
One tempting application, still under exploration, is to PICAXE control an efficient Jaycar "Camping Shower" submersible pump. These run on 12V DC (but draw under 1A) and could pump irrigation or solar heated water only under suitable situations, such as at night or when certain temperatures were reached. Check **http://manuka.orcon.net.nz/solarh2o.htm** for my initial ideas . . .

You could also modify the code suitably (use HIGH or LOW of course rather than PWM!) if you wish this transistor to control a sensitive relay such as the DSE P-8005. Simply remove the motor and connect leads to the relay's energising coil instead, leaving the diode in place.

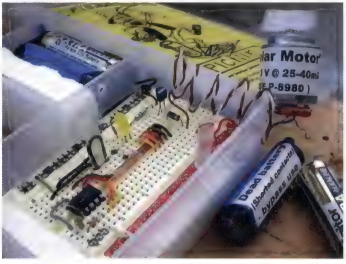


SC PICAXE MOTOR CONTROLLER

Once again, it's very similar to previous months – we make changes to the output circuit and the code inside the PICAXE itself. Note the supply is no longer 6V – see the comments about the 5V rail in the text.

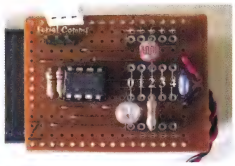


The usual protoboard component layout, with the "PICnik Box" mockup below.



As usual, for clarity, we have made a few minor component position changes between this photo and the protoboard layout above. Oh, you noticed the LED, did you? That's yet another variation . . . one which we have covered overleaf. Note the new use for dead batteries as shorting cells!

As we said previously, even though protoboard is convenient for lashing together experimental circuits, you don't have to use it. The photos at right show a hybrid approach, with most parts soldered to stripboard, but with IC socket strips (DSE P-4300) used for quick "plug in" component changes. Such a setup offers cheaper and more compact circuits and flexibility when away from a soldering iron.



Photos: Andrew <copurnicus@paradise.net.nz>

PICAXE-08 COMMANDS USED THIS MONTH: symbol

SYMBOL The only new (pseudo) command here is "symbol", which makes programs much more lucid, since "plain English" words can be used instead for algebraic variables. Best of all, symbol doesn't crib on the PICAXE memory, so you can now blithely redefine those messy b0, b1s with no program overhead – not even on the set-up lines text entry either.

BASIC PROGRAM LISTING

(This can also be downloaded from http://picaxe.orcon.net.nz/motorpwm.bas)

```
' Demo PWM motor demo- PICAXE-08 May 2003 SilChip Ver 1.0 11th Mar.03
' Best assembled & tested with solderless "PICNIK" box as detailed SilChip Feb.03
' Refer http://picaxe.orcon.net.nz for background info & potential of PICAXE-08!
' Extra parts=DSE P-8980 "Solar Motor", 4.7k resistor, NPN BC547 transistor
' General Si diode & 100-220nF polyester cap (both to stop motor hash & "back emf")
' Dummy cell for 4.5V use. Optional counter =cheap calculator(!) +LDR & heatshrink
' New commands here = symbol
' Ref.PICAXE prog.editor.pdf help files,& BASIC Stamp 1 manuals etc for insights
'      via Stan. SWAN (MU@W, New Zealand)  => s.t.swan@massey.ac.nz <=
'-------------------------------------------------------------------------
' Byte variables      b0= slowing down, b1 = speeding up, b2= slow spin demo
'-------------------------------------------------------------------------
'   Lines beginning ' are program documentation & could be ignored if need be.
'   Program available for web download => http://picaxe.orcon.net.nz/motorpwm.bas
'-------------------------------------------------------------------------
symbol slowdown = b0                'redefine  variables b0, b1, b2
symbol speedup  = b1                ' using PICAXE "symbol" command
symbol slowspin = b2                ' to make easier recall/understanding

kickstart:                          ' brief routine to overcome initial motor friction
  pwm 2,255,8                       ' 8 industrial strength pwm cycles to pin 2
wait 2                              ' short wait before main routine begins

pwmspin:                            ' main pwm demo routine
  pulsout 4,3000                    ' pulse LED pin 4 for 3mSec to indicate start
   for speedup = 70 to 255 step 1   ' values < 70 found unable to easily spin motor
  pwm 2,speedup,4                   ' 4 cycles at pin 2 of increasing pwm duty
next speedup                        ' continue to full speed (255 = 100%)

for slowdown = 255 to 70 step -1    ' slow motor down at same rate
  pwm 2,slowdown,4                  ' 4 cycles at pin 2 of decreasing pwm duty
next slowdown                       ' continue until at slowest reliable speed

for slowspin= 1 to 80               ' longer  slow  speed spin demo- repeat 80 times
  pwm 2,70,10                       ' 10  cycles 70/255 % of 5V at pin 2
next slowspin                       ' continue loop

goto pwmspin                        ' repeat entire motor spin demo routine
```

Some more references and parts suppliers . . .

1. **http://picaxe.orcon.net.nz Authors enthusiastic web site – updated with many pictures and DIY details.**
2. **http://picaxe.orcon.net.nz/motorpwm.bas program listing to copy and paste to PICAXE editor.**
3. **" The Robot Builders Bonanza" McComb. TAB Books 2000 (DSE B-1599) has outstanding motor inter facing details (particularly Steppers & Servos Ch.19-20).**
4. **Dick Smith Electronics "Solar Motor" (Cat P-8980; approx $3) (3V @ ~30mA). The P-8005 relay, under 42mA at 5V, can switch up to 2A at 150V. Other mentioned items (capacitor, diode, transistors, heatshrink, etc) via DSE also.**
5. **Pocket calculator – most bargain and stationery stores. $2-$4 range.**
6. **Jaycar Electronics "Camping Shower" (Cat YS-2800; approx. $27).**
7. **Oatley Electronics (www.oatleyelectronics.com) and Microzed (www.microzed.com.au) now stock PICAXE-08 ICs and many accessories.**

NEXT MONTH: More motor madness

So – your triple fives are now in the bin?
Since, with flair, "08" s look certain to win.
But – you hanker for more –
Motor circuits galore?
Next up we'll "step" and "serve" spin!

A Poor Man's Counter

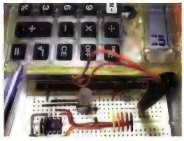
To stimulate your lateral thinking, here is a simple enhancement for our earlier circuits that offers optically coupled LCD counting.

Forget $$ LCD displays and interfacing: we're going to use a cheap pocket calculator.

Pocket calculators sell for only a few dollars, yet offer tempting counting prospects by just exploiting the old schoolboy "1/+/=/=/=" key stroke routine.

The carbon-impregnated pad which normally bridges out calculator key contacts offers about 10kΩ resistance. This is (aha!) a value close to a LDR's bright light resistance. (LDR dark resistance is many megohms – it can be regarded as virtually open circuit).

After disassembly, two neat holes are drilled in the PC board near the "=" key and two thin wires are soldered across the "=" key grid contacts.



Solder an LDR to these two wires, then black-heatshrink the LDR inside a suitable tube, so that stray light will be cut and triggering will be just from an LED when in the tube's other end.

A suitable PICAXE-generated flash from this LED is now as good as a key press to the modified calculator, although debouncing circuitry (and LDR dark "settling") tends to limit response rate to about once a second.

Most auto-power-off calculators will shut down after some 10 minutes of inactivity too, so perhaps choose an "always on" type (ie, cheap-n-nasty!) if your counting application has only light traffic. **SC**

OATLEY'S "PIC-AXEALL" BREADBOARD KIT

In yet another variation on the protoboard theme, Oatley Electronics have released a breadboard kit especially designed for PICAXE (and PIC) experimenters and developers.

More importantly, the kit is very cheap, especially when you consider what it includes (significantly cheaper than going the "protoboard" route and much simpler than going down the stripboard path).

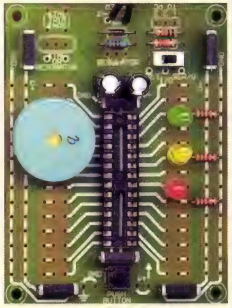
The kit (Cat K193) includes:

- a specially designed PC board with a 28-pin DIL IC socket, capable of handling all PICAXE and most PIC chips
- the PC serial interface (10kΩ and 22kΩ resistor) along with the programming slide switch
- a piezo speaker
- a 5.5V DC mains plugpack and 3.3V or 3.9V zener diode power supply (there is also provision for an optional 7805 regulator if more power is required for higher current outputs).
- three different coloured status LEDs (with 2.2kΩ resistors).
- a pushbutton switch

No chip is supplied with the kit, giving complete flexibility as to which particular chip is used. If the type of PICAXE chip ordered with the kit requires a crystal or resonator, it will be supplied with the chip.

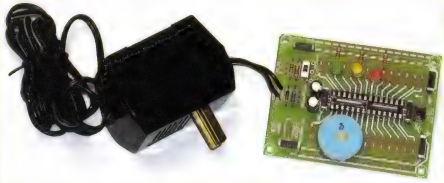
The top side of the PC board is screen-printed with both component positions and the tracks, or connection paths, underneath the board. Four mounting holes are also provided

The board has power supply (+ & -) rails along both edges (similar to the protoboard arrangement) while each of the pins on the IC socket is brought out to a pad, which can be connected through to other pads, supply rails, etc.



Two electrolytic and several 22nF capacitors are spread around the board to ensure a clean DC supply.

While intended as a breadboard, there is nothing to stop the board being used for a permanent PIC/PICAXE project. If it is too big (at 80 x 60mm – shown above life size) it can be trimmed to an appropriate size.



At $12.50, we believe this kit is very good value for money, particularly as it includes the plugpack supply. It is available from Oatley Electronics, PO Box 89, Oatley NSW 2223 (Phone 02 9584 3563, Fax 02 9584 3561) or via **www.oatleyelectronics.com**.

Silicon Chip Back Issues

April 1989: Auxiliary Brake Light Flasher; What You Need to Know About Capacitors; 32-Band Graphic Equaliser, Pt.2

May 1988: Build A Synthesised Tom-Tom; Biofeedback Monitor For You?; Stereo Audio Filter For Suppressing TV Interference.

July 1988: Exhaust Gas Monitor; Experimental Mains Hum Sniffers; Compact Ultrasonic Car Alarm; The NSW 86 Class Electrics.

September 1988: 2-Chip Portable AM Stereo Radio Pt.1; High Or Low Fluid Level Detector; Studio Series 20-Band Stereo Equaliser, Pt.2.

October 1989: FM Radio Intercom For Motorbikes Pt.1; GaAsFet Preamplifier For Amateur TV; 2-Chip Portable AM Stereo Radio, Pt.2.

November 1989: Radfax Decoder For Your PC (Displays Fax, RTTY & Morse); FM Radio Intercom For Motorbikes, Pt.2; 2-Chip Portable AM Stereo Radio, Pt.3; Floppy Disk Drive Formats & Options.

January 1990: High Quality Sine/Square Oscillator; Service Tips For Your VCR; Phone Patch For Radio Amateurs; Active Antenna Kit; Designing UHF Transmitter Stages.

February 1990: A 16-Channel Mixing Desk; Build A High Quality Audio Oscillator, Pt.2; The Incredible Hot Canaries; Random Wire Antenna Tuner For 6 Metres; Phone Patch For Radio Amateurs, Pt.2.

March 1990: Delay Unit For Automatic Antennas; Workout Timer For Aerobics Classes; 16-Channel Mixing Desk, Pt.2; Using The UC3906 SLA Battery Charger IC.

April 1990: Dual Tracking ±50V Power Supply; Voice-Operated Switch With Delayed Audio; 16-Channel Mixing Desk, Pt.3; Active CW Filter.

June 1990: Multi-Sector Home Burglar Alarm; Build A Low-Noise Universal Stereo Preamplifier; Load Protector For Power Supplies.

July 1990: Digital Sine/Square Generator, Pt.1 (covers 0-500kHz); Burglar Alarm Keypad & Combination Lock; Build A Simple Electronic Die; A Low-Cost Dual Power Supply.

August 1990: High Stability UHF Remote Transmitter; Universal Safety Timer For Mains Appliances (8 Minutes); Horace The Electronic Cricket; Digital Sine/Square Generator, Pt.2.

September 1990: A Low-Cost 3-Digit Counter Module; Build A Simple Shortwave Converter For The 2-Metre Band; The Care & Feeding Of Nicad Battery Packs (Getting The Most From Nicad Batteries).

October 1990: The Dangers of PCBs; Low-Cost Siren For Burglar Alarms; Dimming Controls For The Discolight; Surfsound Simulator; DC Offset For DMMs; NE602 Converter Circuits.

November 1990: Connecting Two TV Sets To One VCR; Build An Egg Timer; Low-Cost Model Train Controller; 1.5V To 9V DC Converter; Introduction To Digital Electronics; A 6-Metre Amateur Transmitter.

January 1991: Fast Charger For Nicad Batteries, Pt.1; Have Fun With The Fruit Machine (Simple Poker Machine); Build A Two-Tone Alarm Module; The Dangers of Servicing Microwave Ovens.

March 1991: Transistor Beta Tester Mk.2; A Synthesised AM Stereo Tuner, Pt.2; Multi-Purpose I/O Board For PC-Compatibles; Universal Wideband RF Preamplifier For Amateur Radio & TV.

May 1991: 13.5V 25A Power Supply For Transceivers; Stereo Audio Expander; Fluorescent Light Simulator For Model Railways; How To Install Multi-TV Outlets, Pt.1.

July 1991: Loudspeaker Protector For Stereo Amplifiers; 4-Channel Lighting Desk, Pt.2; How To Install Multiple TV Outlets, Pt.2; Tuning In To Satellite TV, Pt.2.

September 1991: Digital Altimeter For Gliders & Ultralights; Ultrasonic Switch For Mains Appliances; The Basics Of A/D & D/A Conversion; Plotting The Course Of Thunderstorms.

October 1991: Build A Talking Voltmeter For Your PC, Pt.1; SteamSound Simulator For Model Railways Mk.II; Magnetic Field Strength Meter; Digital Altimeter For Gliders, Pt.2; Military Applications Of R/C Aircraft.

November 1991: Build A Colour TV Pattern Generator, Pt.1; A Junkbox 2-Valve Receiver; Flashing Alarm Light For Cars; Digital Altimeter For Gliders, Pt.3; Build A Talking Voltmeter For Your PC, Pt.2.

December 1991: TV Transmitter For VCRs With UHF Modulators; IR Light Beam Relay; Build A Colour TV Pattern Generator, Pt.2; Index To Vol.4.

March 1992: TV Transmitter For VHF VCRs; Thermostatic Switch For Car Radiator Fans; Coping With Damaged Computer Directories; Valve Substitution In Vintage Radios.

April 1992: IR Remote Control For Model Railroads; Differential Input Buffer For CROs; Understanding Computer Memory; Aligning Vintage Radio Receivers, Pt.1.

June 1992: Multi-Station Headset Intercom, Pt.1; Video Switcher For Camcorders & VCRs; IR Remote Control For Model Railroads, Pt.3; 15-Watt 12-240V Inverter; A Look At Hard Disk Drives.

October 1992: 2kW 240VDC - 240VAC Sinewave Inverter; Multi-Sector Home Burglar Alarm, Pt.2; Mini Amplifier For Personal Stereos; A Regulated Lead-Acid Battery Charger.

February 1993: Three Projects For Model Railroads; Low Fuel Indicator For Cars; Audio Level/VU Meter (LED Readout); An Electronic Cockroach; 2kW 240VDC To 240VAC Sinewave Inverter, Pt.5.

March 1993: Solar Charger For 12V Batteries; Alarm-Triggered Security Camera; Reaction Trainer; Audio Mixer for Camcorders; A 24-Hour Sidereal Clock For Astronomers.

April 1993: Solar-Powered Electric Fence; Audio Power Meter; Three-Function Home Weather Station; 12VDC To 70VDC Converter; Digital Clock With Battery Back-Up.

June 1993: AM Radio Trainer, Pt.1; Remote Control For The Woofer Stopper; Digital Voltmeter For Cars; Windows-Based Logic Analyser.

July 1993: Single Chip Message Recorder; Light Beam Relay Extender; AM Radio Trainer, Pt.2; Quiz Game Adjudicator; Windows-Based Logic Analyser, Pt.2; Antenna Tuners – Why They Are Useful.

August 1993: Low-Cost Colour Video Fader; 60-LED Brake Light Array; Microprocessor-Based Sidereal Clock; Satellites & Their Orbits.

September 1993: Automatic Nicad Battery Charger/Discharger; Stereo Preamplifier With IR Remote Control, Pt.1; In-Circuit Transistor Tester; +5V to +15V DC Converter; Remote-Controlled Cockroach.

October 1993: Courtesy Light Switch-Off Timer For Cars; Wireless Microphone For Musicians; Stereo Preamplifier With IR Remote Control, Pt.2; Electronic Engine Management, Pt.1.

November 1993: High Efficiency Inverter For Fluorescent Tubes; Stereo Preamplifier With IR Remote Control, Pt.3; Siren Sound Generator; Engine Management, Pt.2; Experiments For Games Cards.

December 1993: Remote Controller For Garage Doors; Build A LED Stroboscope; Build A 25W Audio Amplifier Module; A 1-Chip Melody Generator; Engine Management, Pt.3; Issues To Volume 6.

January 1994: 3A 40V Variable Power Supply; Solar Panel Switching Regulator; Printer Status Indicator; Mini Drill Speed Controller; Stepper Motor Controller; Active Filter Design; Engine Management, Pt.4.

February 1994: Build A 90-Second Message Recorder; 12-240VAC 200W Inverter; 0.5W Audio Amplifier; 3A 40V Adjustable Power Supply; Engine Management, Pt.5; Airbags In Cars – How They Work.

March 1994: Intelligent IR Remote Controller; 50W (LM3876) Audio Amplifier Module; Level Crossing Detector For Model Railways; Voice Activated Switch For FM Microphones; Engine Management, Pt.6.

April 1994: Sound & Lights For Model Railway Level Crossings; Discrete Dual Supply Voltage Regulator; Universal Stereo Preamplifier; Digital Water Tank Gauge; Engine Management, Pt.7.

May 1994: Fast Charger For Nicad Batteries; Induction Balance Metal Locator; Multi-Channel Infrared Remote Control; Dual Electronic Dice; Simple Servo Driver Circuits; Engine Management, Pt.8.

June 1994: A Coolant Level Alarm For Your Car; 80-Metre AM/CW Transmitter For Amateurs; Converting Phono Inputs To Line Inputs; PC-Based Nicad Battery Monitor; Engine Management, Pt.9.

July 1994: Build A 4-Bay Bow-Tie UHF TV Antenna; PreChamp 2-Transistor Preamplifier; Steam Train Whistle & Diesel Horn Simulator; 6V SLA Battery Charger; Electronic Engine Management, Pt.10.

August 1994: High-Power Dimmer For Incandescent Lights; Microprocessor-Controlled Morse Keyer; Dual Diversity Tuner For FM Microphones; Pt.11; Nicad Charger For Resurrecting Nicad Batteries); Electronic Engine Management, Pt.11.

September 1994: Automatic Discharger For Nicad Battery Packs; MiniVox Voice Operated Relay; Image Intensified Night Viewer; AM Radio For Weather Beacons; Dual Diversity Tuner For FM Microphones, Pt.2; Electronic Engine Management, Pt.12.

October 1994: How Dolby Surround Sound Works; Dual Rail Variable Power Supply; Build A Talking Headlight Reminder; Electronic Ballast For Fluorescent Lights; Electronic Engine Management, Pt.13.

November 1994: Dry Cell Battery Rejuvenator; Novel Alphanumeric Clock; 80-Metre DSB Amateur Transmitter; Twin-Cell Nicad Discharger (See May 1993); How To Plot Patterns Direct to PC Boards.

December 1994: Easy-To-Build Car Burglar Alarm; Three-Spot Low Distortion Sinewave Oscillator; Infrared – A Pesky Electronic Cricket; Remote Control System for Models, Pt.1; Index to Vol.7.

January 1995: Sun Tracker For Solar Panels; Battery Saver For Torches; Dolby Pro-Logic Surround Sound Decoder, Pt.2; Dual Channel UHF Remote Control; Stereo Microphone Preamplifier.

February 1995: 2 x 50W Stereo Amplifier Module; Digital Effects Unit For Musicians; 6-Channel Thermometer With LCD Readout; Wide Range Electrostatic Loudspeakers, Pt.1; Oil Change Timer For Cars; Remote Control System For Models, Pt.2.

March 1995: 2 x 50W Stereo Amplifier, Pt.1; Subcarrier Decoder For FM Receivers; Wide Range Electrostatic Loudspeakers, Pt.2; IR Illuminator For CCD Cameras; Remote Control System For Models, Pt.3.

April 1995: FM Radio Trainer, Pt.1; Photographic Timer For Darkrooms; Balanced Microphone Preamp. & Line Filter; 50W/Channel Stereo Amplifier, Pt.2; Wide Range Electrostatic Loudspeakers, Pt.3; 8-Channel Decoder For Radio Remote Control.

May 1995: Build A Guitar Headphone Amplifier; FM Radio Trainer, Pt.2; Transistor/Mosfet Tester For DMMs; A 16-Channel Decoder For Radio Remote Control; Introduction to Satellite TV.

June 1995: Build A Satellite TV Receiver; Train Detector For Model Railways; 1W Audio Amplifier Trainer; Low-Cost Video Security System; Multi-Channel Radio Control Transmitter For Models, Pt.1.

July 1995: Electric Fence Controller; How To Run Two Trains On A Single Track (Incl. Lights & Sound); Setting Up A Satellite TV Ground Station; Build A Reliable Door Minder.

August 1995: Fuel Injector Monitor For Cars; Gain Controlled Microphone Preamp; Audio Lab PC-Controlled Test Instrument, Pt.1; How To Identify IDE Hard Disk Drive Parameters.

September 1995: Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.1; Keypad Combination Lock; The Vater Voice; Jacob's Ladder Display; Audio Lab PC-Controlled Test Instrument, Pt.2.

October 1995: 3-Way Loudspeaker System; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.2; Build A Fast Charger For Nicad Batteries.

November 1995: Mixture Display For Fuel Injected Cars; CB Transverter For The 80M Amateur Band, Pt.1; PIR Movement Detector.

December 1995: Engine Immobiliser; 5-Band Equaliser; CB Transverter For The 80M Amateur Band, Pt.2; Subwoofer Controller; Knock Sensing In Cars; Index To Volume 8.

January 1996: Surround Sound Mixer & Decoder, Pt.1; Magnetic Card Reader; Build An Automatic Sprinkler Controller; IR Remote Control For The Railpower Mk.2; Battery Zapping Nicad Battery For Long Life.

April 1996: 125W Audio Amplifier Module; Knock Indicator For Leaded Petrol Engines; Multi-Channel Radio Control Transmitter; Pt.3.

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June 1998: BassBox CAD Loudspeaker Software Reviewed; Stereo Simulator (uses delay chip); Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

July 1998: Build A VGA Digital Oscilloscope, Pt.1; Remote Control Extender For VCRs; 2A SLA Battery Charger; 3-Band Parametric Equaliser; Single Channel 8-Bit Data Logger.

August 1998: Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2; 350W Amplifier Module; Masthead Amplifier For TV & FM; Cathode Ray Oscilloscopes, Pt.4.

September 1998: VGA Oscilloscope, Pt.3; IR Stereo Headphone Link, Pt.1; High Quality PA Loudspeaker; 3-Band HF Amateur Radio Receiver; Cathode Ray Oscilloscopes, Pt.5

October 1998: Send Video Signals Over Twisted Pair Cable; Power Control With A Light Dimmer; 600W DC-DC Converter For Car Hifi Systems, Pt.1; IR Stereo Headphone Link, Pt.2; Build A Multi-Channel Sound System, Pt.1: Multi-Channel Radio Control Transmitter, Pt.8.

November 1998: 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; Repairing Domestic Light Dimmers; Multi-Media Sound System, Pt.2; 600W DC-DC Converter For Car Hifi Systems, Pt.2.

December 1998: Active Filter Cleans Up Your CW Reception; A Fast Clock For Railway Modellers; Laser Pistol & Electronic Target; Build A Sound Level Meter; 8-Channel Stereo Mixer, Pt.2; Index To Vol.9.

January 1997: How To Network Your PC; Control Panel For Multiple Smoke Alarms, Pt.1; Build A Pink Noise Source; Computer Controlled Dual Power Supply, Pt.1: Digi-Temp Monitors Eight Temperatures.

February 1997: PC-Controlled Moving Message Display; Computer Controlled Dual Power Supply, Pt.2; Alert-A-Phone Loud Sounding Telephone Alarm; Control Panel For Multiple Smoke Alarms, Pt.2.

March 1997: Driving A Computer By Remote Control; Plastic Power PA Amplifier (175W); Signalling & Lighting For Model Railways; Build A Jumbo LED Clock; Cathode Ray Oscilloscopes, Pt.7.

April 1997: Simple Timer With No ICs; Digital Voltmeter For Cars; Loudspeaker Protector For Stereo Amplifiers; Model Train Controller; A Look At Signal Tracing; Pt.1; Cathode Ray Oscilloscopes, Pt.8.

May 1997: Neon Tube Modulator For Light Systems; Traffic Lights For A Model Intersection; The Superhet Receiver — It Writes Messages In Thin Air; A Look At Signal Tracing; Pt.2; Cathode Ray Oscilloscopes, Pt.9.

June 1997: PC-Controlled Thermometer/Thermostat; TV Pattern Generator, Pt.1; Audio/RF Signal Tracer; High-Current Speed Controller For 12V/24V Motors; Manual Control Circuit For Stepper Motors

July 1997: Infrared Remote Volume Control; A Flexible Interface Card For PCs; Signalling & Lighting For Railways; Colour TV Pattern Generator, Pt.2; An In-Line Mixer For Radio Control Receivers.

August 1997: The Bass Barrel Subwoofer; 500 Watt Audio Power Amplifier Module; A Tens Unit For Pain Relief; Addressable PC Card For Stepper Motor Control; Remote Controlled Gates For Your Home.

September 1997: Multi-Spark Capacitor Discharge Ignition; 500W Audio Power Amplifier, Pt.2; A Video Security System For Your Home; PC Card For Controlling Two Stepper Motors; Hifi On A Budget.

October 1997: Build A Digit Tachometer; Add Control Looking To Your Car; PC-Controlled 6-Channel Thermometer; 500W Audio Power Amplifier, Pt.3; Customising The Windows 95 Start Menu.

November 1997: Heavy Duty 10A 240VAC Motor Speed Controller; Easy-To-Use Cable & Wiring Tester; Build A Musical Doorbell; Recycling Foam Speaker Surrounds; Understanding Electric Lighting Pt.1.

December 1997: Speed Alarm For Cars; 2-Axis Robot With Gripper; Stepper Motor Driver With Onboard Buffer; Power Supply For Stepper Motor Cards; Understanding Electric Lighting Pt.2; Index To Vol.10.

January 1998: Build Your Own 4-Channel Lightshow, Pt.1 (runs off 12VDC or 12VAC); Computer Control System For Model Railways, Pt.1; Pan Controller For CCD Cameras.

February 1998: Multi-Purpose Fast Battery Charger, Pt.1; Telephone Exchange Simulator For Testing; Command Control System For Model Railways, Pt.2; Build Your Own 4-Channel Lightshow, Pt.2.

April 1998: Automatic Garage Door Opener, Pt.1; 40V 8A Adjustable Power Supply, Pt.1; PC-Controlled 0-30kHz Sinewave Generator; Build A Laser Light Show; Understanding Electric Lighting; Pt.6.

May 1998: Troubleshooting Your PC, Pt.1; Build A 3-LED Logic Probe; Automatic Garage Door Opener, Pt.2; Command Control For Model Railways, Pt.4; 40V 8A Adjustable Power Supply, Pt.2.

June 1998: Troubleshooting Your PC, Pt.2; Universal High Energy Ignition System; The Roadies' Friend Cable Tester; Universal Stepper Motor Controller; Command Control For Model Railways, Pt.5.

July 1998: Troubleshooting Your PC, Pt.3; 15W/Ch Class-A Audio Amplifier, Pt.1; Simple Charger For 6V & 12V SLA Batteries; Automatic Semiconductor Analyser; Understanding Electric Lighting, Pt.8.

August 1998: Troubleshooting Your PC, Pt.4 (Adding Extra Memory); Simple I/O Card With Automatic Data Logging; Build A Beat Triggered Strobe; 15W/Ch Class-A Stereo Amplifier, Pt.2.

September 1998: Troubleshooting Your PC, Pt.5; A Blocked Air-Filter Alarm; Wax-Wax Pedal For Guitars; Jacob's Ladder; Gear Change Indicator For Cars; Capacity Indicator For Rechargeable Batteries.

October 1998: Lab Quality AC Millivoltmeter, Pt.1; PC-Controlled Stress-O-Meter; Versatile Electronic Guitar Limiter; 12V Trickle Charger For Float Conditions; Adding An External Battery Pack To Your Flashgun.

November 1998: The Christmas Star; A Turbo Timer For Cars; Build A Poor Man's Mixer, Pt.1; FM Transmitter For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Improving AM Radio Reception, Pt.1.

December 1998: Engine Immobiliser Mk.2; Thermocouple Adaptor For DMMs; Regulated 12V DC Plugpack; Build A Power Machine; Pt.2; Improving AM Radio Reception, Pt.2; Mixer Module For F3B Gliders.

January 1999: High-Voltage Megohm Tester; Getting Started With BASIC Stamp; LED Bargraph Ammeter For Cars; Keypad Engine Immobiliser; Improving AM Radio Reception, Pt.3.

March 1999: Getting Started With Linux; Pt.1: Build A Digital Anemometer; Simple DIY PIC Programmer; Easy-To-Build Audio Compressor; Low Distortion Audio Signal Generator, Pt.2.

April 1999: Getting Started With Linux; Pt.2: High-Power Electric Fence Controller; Bass Cube Subwoofer; Programmable Thermostat/Thermometer; Build An Infrared Remote Control For Cars.

May 1999: The Line Dancer Robot; An X-Y Table With Stepper Motor Control, Pt.1; Three Electric Fence Testers; Heart Of LEDs; Build A Carbon Monoxide Alarm; Getting Started With Linux; Pt.3.

June 1999: FM Radio Tuner Card For PCs, X-Y Table With Stepper Motor Control, Pt.2; Programmable Ignition Timing Module For Cars, Pt.1; Hard Disk Drive Upgrades Without Reinstalling Software?

July 1999: Build A Dog Silencer; 10µH to 19.99mH Inductance Meter; Build An Audio-Video Transmitter; Programmable Ignition Timing Module For Cars, Pt.2; X-Y-Z Table With Stepper Motor Control, Pt.3.

August 1999: Remote Modem Controller; Daytime Running Lights For Cars; Build A PC Monitor Checker; Switching Temperature Controller; XYZ Table With Stepper Motor Control, Pt.4; Electric Lighting, Pt.14.

September 1999: Autonomouse The Robot, Pt.1; Voice Direct Speech Recognition Module; Digital Voltmeter Adaptor; Build A PC/XT Table With Stepper Motor Control, Pt.5; Peltier-Powered Car Cooler.

October 1999: Build The Railpower Model Train Controller, Pt.1; Semiconductor Curve Tracer; Autonomouse The Robot, Pt.2; XYZ Table With Stepper Motor Control, Pt.6; Programming Atmel's Flash Microcontrollers.

November 1999: Setting Up An Email Server; Speed Alarm For Cars, Pt.1; LED Christmas Tree; Intercom Station Expander; Foldback Loudspeaker System; Railpower Model Train Controller, Pt.2.

December 1999: Solar Panel Regulator; PC Powerhouse (gives +12V and -6V & +5V rails); Programmable Ignition Timing Module For Cars, Pt.2; Railpower Model Train Controller, Pt.3; Index To Vol.12.

January 2000: Spring Reverberation Module; An Audio-Video Test Generator; Build The Picman Programmable Robot; A Parallel Port Interface Card; DMM-Controlled Thermometer.

February 2000: Multi-Sector Sprinkler Controller; A Digital Voltmeter For Your Car; An Ultrasonic Parking Radar; Build A Safety Switch Checker; Build A Sine/Square Wave Oscillator.

March 2000: Resurrecting An Old Computer; Low Distortion 100W Amplifier Module, Pt.1; Electronic Ignition For Cars, Pt.1; Build Display; Glowplug Driver For Powered Models; The OzTrip Car Computer, Pt.1.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; Build A LED Dice (With PIC Microcontroller); Low-Cost AT Keyboard Translator (Converts IBM Scan-Codes To ASCII); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge With Digital Readout; Parallel Port VHF-FM Receiver; Li'l Powerhouse Switchmode Power Supply (1.23V to 40V) Pt.1; CD Compressor For Cars Or The Home.

July 2000: A Moving Message Display; Compact Fluorescent Lamp Driver; El-Cheapo Modules For Train Control; Li'l Powerhouse Switchmode Power Supply (1.23V to 40V) Pt.2.

August 2000: Build A Theremin For Really Eerie Sounds; Come In Spinner (writes messages in "thin-air"); Proximity Switch For 240VAC Lamps; Structured Cabling For Computer Networks.

September 2000: Build A Swimming Pool Alarm; An 8-Channel PC Relay Board; Fuel Mixture Display For Cars, Pt.1; Protoboards – The Easy Way Into Electronics, Pt.1; Cybug The Solar Fly.

October 2000: Guitar Jammer For Practice & Jam Sessions; Booze Buster Breath Tester; A Wand-Activated Doorbell Camera; Installing A Free-Air Subwoofer In Your Car; Fuel Mixture Display For Cars, Pt.2.

November 2000: Santa & Rudolf Christie Display; Build A 2-Channel Guitar Preamplifier, Pt.1; Message Bank & Missed Call Alert; Programmable Electronic Thermostat; Protoboards – The Easy Way Into Electronics, Pt.3.

December 2000: Home Networking For Shared Internet Access; Build A Right-While-Left Touch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Index to Vol.13.

January 2001: How To Transfer LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & TestBed.

February 2001: An Easy Way To Make PC Boards; Li'l Pulser Train Controller; A MIDI Interface For PCs; Build The Bass Blaper; 2-Metre Groundplane Antenna; The LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Making Photo Resist PC Boards; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Checkerboard; Protoboards – The Easy Way Into Electronics, Pt.5; A Simple MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; Tremolo Unit For Musicians; Minimitter FM Stereo Transmitter; Intelligent Nicad Battery Charger.

May 2001: Powerful 12V Mini Stereo Amplifier; Two White-Led Torches To Build; PowerPak – A Multi-Purpose Power Supply; Using Linux To Share An Internet Connection, Pt.1; Tweaking Windows With TweakUI.

June 2001: Fast Universal Battery Charger, Pt.1; Phonoma – Call, Listen In & Switch Devices On & Off; Li'l Snooper – A Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2; A PC To Die For, Pt.1 (Building Your Own PC).

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pic-Toc – A Simple Alarm Clock; Fast Universal Battery Charger, Pt.2; A PC To Die For, Pt.2; Backing Up Your Email.

August 2001: DI Box For Musicians; 200W Mosfet Amplifier Module; Headlight Reminder; 40MHz 6-Digit Frequency Counter Module; A PC To Die For, Pt.3; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s – Rippers & Encoders; Build Your Own MP3 Jukebox, Pt.1; PC-Controlled Mains Switch; Personal Noise Source For Tinnitus Sufferers; The Sooper Sooper Directional Microphone; Using Linux To Share An Internet Connection, Pt.4.

November 2001: Ultra-LD 100W RMS/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator For Cars; Low-Cost Audio/Video Distribution Amplifier; Short Message Recorder Player; Computer Tips.

December 2001: A Look At Windows XP; Build A PC Infrared Transceiver; Ultra-LD 100W RMS/Ch Stereo Amplifier, Pt.2; Party Lights – An Intriguing Colour Display; PIC Fun – Learning About Micros.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap 'n Easy Motorbike Alarm; 100W RMS/Channel Stereo Amplifier, Pt.3; Build A Rascsi Interface Card; On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio-Video Link; Assemble Your Own 2-Way Tower Speakers; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard Or Mouse; XYZ Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; The Itsy-Bitsy USB Lamp; 6-Channel IR Remote Volume Control, Pt.1; RIAA Preamplifier For Magnetic Cartridges; 12/24V Intelligent Solar Power Battery Charger; Programming Tones Using Your PC's Soundcard.

April 2002: Automatic Single-Channel Light Dimmer, Pt.1; Build A Water Level Indicator; Multiple-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2.

May 2002: 32-LED Knightrider; The Battery Guardian (Cuts Power When the Battery Is Flat); Build A Stereo Headphone Amplifier; Automatic Single-Channel Light Dimmer; Pt.2; Stepper Motor Controller.

June 2002: Lock Out The Bad Guys with A Firewall; Remote Volume Control For Stereo Amplifiers; "The Machines" Metal Locator; Compact 0-90A Motor Speed Controller; Constant High-Current Source.

July 2002: Telephone Headset Adaptor; Rolling Code 4-Channel UHF Remote Control; Remote Volume Control For The Ultra-LD Stereo Amplifier; Direct Conversion Receiver For Radio Amateurs, Pt.1.

August 2002: Digital Instrumentation Software For Your PC; Digital Storage Logic Probe; Digital Thermometer/Thermostat; Quad Card Interface For PC Test Instruments; Direct Conversion Receiver For Radio Amateurs, Pt.2; Spruce Up Your PC With 3Pr-Silva Icons.

September 2002: 12V Fluorescent Lamp Inverter; 8-Channel Infrared Remote Control; 50-Watt DC Electronic Load; Driving Light & Accessory Protector For Cars; Spyware – An Update.

October 2002: Speed Controller For Universal Motors; PC Parallel Port Wizard; "Whistle & Part" Cable Tracer; Build An AVR ISP Serial Programmer; Watch 3D TV In Your Own Home.

November 2002: SuperCharger For NiCd/NiMH Batteries, Pt.1: Windows-Based EPROM Programmer, Pt.1; 4-Digit Crystal-Controlled Timing Module; Using Linux To Share An Optus Cable Modem, Pt.1.

December 2002: Receiving TV From Satellites: Pt.1; The Microsmitter Stereo FM Transmitter; Windows-Based EPROM Programmer, Pt.2; SuperCharger For NiCd/NiMH Batteries: Pt.2; Simple VHF FM/AM Radio; Using Linux To Share An Optus Cable Modem, Pt.2.

January 2003: Receiving TV From International Satellites, Pt.2; Reader/Programmer For Smart Cards; SC480 50W RMS Amplifier Module, Pt.1; A "Tiptronic-Style" Gear Indicator; Activs 3-Way Crossover For Loudspeakers; Using Linux To Share An Optus Cable Modem, Pt.3.

February 2003: The PortaPal Public Address System, Pt.1: 240V Mains Filter For HiFi Systems; SC480 50W RMS Amplifier Module, Pt.2; Windows-Based EPROM Programmer, Pt.3; Using Linux To Share An Optus Cable Modem, Pt.4; Tracking Down Elusive PC Faults.

March 2003: LED Lighting For Your Car; Peltier-Effect Tinnie Cooler; PortaPal Public Address System, Pt.2; 12V SLA Battery Float Charger; Build The Little Dynamite Loudspeaker; Fun With The HDAVR (Build A Shop Door Minder); SuperCharger Addendum; Emergency Beacons.

April 2003: Video-Audio Booster For Home Theatre Systems; A Highly-Flexible Keypad Alarm; Telephone Dialler For Burglar Alarms; Three Do-It-Yourself PIC Programmer Kits: More Fun With The PICAXE, Pt.3 (Heartbeat Simulator); Electric Shutter Release For Cameras

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Triac tester wanted

Have you ever published a circuit to test Triacs? If not, what is the easy way to test a Triac? (Y. G., via email).

● We have not published a Triac tester and nor is there any easy way to test them for parameters such as blocking voltage, holding current, gate sensitivity etc.

However, if you want a simple safe check, use a 12VAC supply, a 12V 20W halogen lamp and a 470Ω resistor to connect the gate to A2. Connect the lamp in series with A2 and the +12V supply. Connecting the gate to A2 (via the 470Ω resistor) should turn on the lamp.

Curtain motor control wanted

I am searching for information on the control of an electric motor for the opening and closing of window curtains. The device would detect a voltage drop or a current increase when the curtain carrier comes to the fully opened or closed position. The operating voltage is 12V at less than 1.5A. (H. B., via email).

● Have a look at the circuit for a remote volume control in the June 2002 issue. It was a low power 5V circuit but could be upgraded to higher current by changing the transistors in the H-pack. The BC328s could be changed to Darlington BD682s and the BC338s to BD681s. The 10Ω current sensing resistor would have to reduced to around 0.5Ω or less.

Speed Alarm for FWD cars

I recently purchased the Speed Alarm kit (SILICON CHIP, November & December 1999) only to find that it does not work for a front-wheel drive car (Mazda 626) as you do not have access to the drive-shaft, only the wheel shafts which rotate too slowly, hence generating too few pulses.

My question is, has anyone produced a modification to the circuit or to the PIC program to overcome this problem? (P. H., via email).

● You can use the Speed Alarm on a front-wheel drive car. Just use more magnets on the wheel drive shaft. Eight should be enough, evenly distributed around the shaft.

In fact, it is not so much that the Speed Alarm does not work for a front-wheel drive but that the speedometer update time is dependent on the number of pulses provided for a given speed from the pickup sensor. So more magnets on the shaft will increase the number of pulses and provide a faster speedometer update.

However, there is another way and this has been mentioned a number of times in past issues: don't bother with magnets and the pickup coil; just use the speed signal from your car's engine management system. The pulsed speed signal connects to the coil input terminal on the PC board, via shielded cable. The shield connection is left open, ie, no need to connect the shield at the pickup point for the engine management speed signal.

Flexitimer does not cycle

I have built the Flexitimer published in the August & September 1995 issues of "Electronics Australia". I find that once the 9V mains adaptor is turned on, the solenoid is energised after about 7s (normal) but will not disengage after a further 7s.

Shouldn't it change output poles on the relay every 7s or is the timer only a straight timer that turns on or off once until the mains is turned off? I have used the Q4 jumper to give the minimum time. (A. S., via email).

● If you want the relay to cycle on and off, you must cut the track between the collector of Q1 and pin 4 of IC1, then connect pin 4 to pin 8 of IC1.

Motor speed controller reversing

I have a 10A Motor Speed Controller kit (June 1997) which I intend to use to drive a 12V DC motor. However, I want to run it in forward and reverse direction.

I am thinking of using a relay to switch polarities but I realise this will cause a short circuit across protection diode D2. I would appreciate any ideas to solve this problem. (D. C., via email).

Bigger displays for PIC TOC

I would like to substitute the existing LEDs in the PIC TOC Alarm Clock (SILICON CHIP, July 2001) with the super large 7-segment displays which are available from Jaycar (Cat. ZD-1850) for $10.95 each for the common cathode type. What would I have to alter on the circuit for this to be done?

Secondly, I have in mind to build the Peltier cooler Esky/fridge from your September 1999 issue and I wish to power it from 240VAC, 12V DC and from solar cells. Can you advise what the solar panel and battery requirements would need to be. (M. S., via email).

● Unfortunately, neither of your project suggestions is practical or feasible. Each digit of the giant LED displays has two LEDs and so it is not feasible to drive them in the PIC alarm clock. You would need the drive circuit used in the Large Digit PIC clock featured in the March 2001 issue.

As far as the Peltier cooler is concerned, you would need a solar panel capable of at least 4A, depending on the cooler used. That would be a very expensive panel.

● The simple way to solve your problem is to use a 2-pole changeover relay. We showed how to use a relay in this way in the L'il Pulser Train controller published in the February 2001 issue. We can supply this issue for $8.80 including postage.

Speed control for distributor tester

I am in the process of building a car distributor tester using a 12V heater fan motor to drive the distributor. I need to vary the speed of the motor to test the centrifugal advance curve of the distributor. The motor draws in excess of 15A on startup and drops to 6A at full speed.

Could you please advise if the high-current speed controller for 12V and 24V DC motors featured in the June 1997 issue would be suitable to vary the speed of this motor? (K. W., via email).

● The June 1997 design would be suitable for handling your load, although we are surprised that the fan motor draws such a high current (both at start-up and when running). We assume that this is without the fan connected and it suggests that there is something wrong with the motor.

As an alternative, you could use a 240V sewing machine motor and control it with the speed control featured in the October 2002 issue. We can supply this issue for $8.80 including postage.

Bridge amplifier for subwoofers

I am building a subwoofer amplifier using the 50W LM3876T chip from your March 1994 amplifier module. My preamp has the extra output to run two modules in bridge mode, so I decided to build two up for extra power.

The first module works perfectly, while the second module is the same as the first except for the output chip. It was only after I had finished, that I noticed the second chip was an LM-3886 (they look identical). The amplifier seems to be working OK except that I noticed that the LM3886 chip was running hotter than the LM3876 chip, so I have switched off for now. The modules are in bridge mode.

My question is, what is the difference between the two? Can the LM3886 be used in the March 1994 project without modification? If not, what modifications are needed? Which chip is best for bridge mode operation when using two?

My sub-woofer has two separate drivers running in a three-chambered bandpass enclosure, so is it possible to use one module for each speaker. Would this be better? I strive for perfection, so I hope you don't mind all the questions.

The transformer I am using is a 200VA type with two secondary windings. These are 25V-0-25V and 22V-0-22V, with a switch to select the one you want. Would either of the chips produce more power into 4Ω or even 2Ω in bridge mode if the lower transformer voltage was used? The DC voltage was 33V compared to the normal 37.5V DC for this project.

I have built up a 5-channel power amplifier using the LM3876T chips for each channel. A 500VA toroidal transformer and 40,000μF of filter capacitors are used to power them. This amplifier has fantastic quality for music and home DVD movies.

I use this 5-channel amplifier with a DVD player with an inbuilt 5.1 AC3, DTS decoder and the new 6-channel IR Remote Volume Control project (SILICON CHIP, March 2002). This setup is much cheaper than buying an all-in-one home theatre amplifier and you get to use amplifiers you have built up in the past. (K. S., Morphett Vale, Vic).

● We would not use the LM3876 and the LM3886 in bridge mode; use either LM3876 or LM3886 - do not mix them. The LM3886 is a higher rated version of the LM3876.

If your subwoofer has separate drivers, it would be much better to drive them from individual amplifier modules rather than in bridge mode. In fact, both the LM3886 and LM3876 are not really all that good in bridge mode because their power output into 4Ω is only slightly more than that into 8Ω.

If you drive the woofers separately with the modules, you can use both the LM3876 and LM3886.

Use 25V + 25V from your transformer. You will not get much more (if any) more power from these chips by changing the supply rails because the chip has internal power limiting (check the article in March 1994, page 80). They will not drive 2Ω loads.

Questions on sound level meter

I'm interested in building the Sound Level Meter from the December 1996 issue. It is to be used to help set up speaker levels in a 5.1 home theatre system but as I'm fairly new to all this I have a few questions:

An ECM-60P type A electret microphone is called for in the design, however I can't find one. Can you suggest a suitable alternative? Should the 10kΩ bias resistor and 68kΩ and 10kΩ feedback resistors be changed to match

Extending The 6-Channel Remote Volume Control

I have just completed the 6-channel IR Remote Volume Control project and am very pleased with it, particularly the professional appearance of the finished unit. I bought my kit from Altronics.

It would be a lot more useful to me if I was able to control the volume of the individual channels, as well as having overall volume control. I noticed in your article that you said that "each of the three channels in each IC is individually addressable and could theoretically be loaded with any attenuation value".

Can you provide information on how to do this? (B. M., via email).

● While it is possible to individually address the attenuators for each of the 6-channels, the design would be much more complex, with more hardware and software. The remote control would need to individually select each channel to be adjusted and you would need more indicators on the front panel, to show what was happening.

If you want to pursue this further, you can find the codes to address each attenuator in the LM1973 data on the National Semiconductor website. An alternative approach would be add a trimpot attenuator at the input of each channel to set up the individual volume levels.

Boosting the 5A speed control

I recently completed the AC Motor Speed Controller from the October 2002 issue. However, I need to use it with an 1850W router. Can the circuit be modified to handle this amount of power? (A. H., via email).

● The two main factors setting the maximum current are the current ratings for diode D3 and the speed switch. As far as the switch is concerned, you could either leave it out altogether or substitute a bigger switch, such as the 10A 240VAC DPDT toggle switch from Jaycar (Cat ST-0575).

To get a higher rated diode, you will need to go to a TO-220 package type such as the MUR1560 rated at 15A, 600V (Jaycar Cat ZR-1030). Make sure these components fit comfortably inside the case.

Note, however, that these modifications will not let you run appliances with 10A ratings on their nameplates. To do that, you would need to use a larger diecast case or otherwise improve the heatsinking of the Triac.

the substitute microphone?

I have found a software-based pink noise generator at: **http://www.nch.com.au**. Can this be used in place of the pink noise kit?

Also I'm not clear on the calibration procedure. It says to connect the pink noise source to the mic input (I assume with the mic disconnected?). Should this be the line level output from the pink noise source or the speaker level output; ie, should I use the line level output from the sound card or the wires that connect to the internal PC speaker?

As the software will only go to -30dB, can I use 700mV as the set point; ie, a 300mV change between 0dB and -30dB? (V. S., via email).

● The Jaycar Cat. AM-4011 microphone would be suitable. No resistor changes are necessary. The pink noise generator signal from the computer sound card would be suitable. However, the 60dB attenuator circuit as used in the SILICON CHIP Pink Noise generator (January 1997 issue) would need to be used to calibrate the sound level meter.

This resistive divider can be added to the output of the sound card.

Does auto lock-up confuse Gear Indicator?

I am interested in the Gear Indicator project featured in the January 2003 issue. I have a VR Commodore with a 4-speed auto and lock-up converter. What do you set the number of gears to? Four or five?

As far as I'm aware, the converter locks up in third under certain conditions, as well as locking up in fourth. This being the case, what would the display indicate, because if you set it for five gears - ie, four plus one for lock-up - and the transmission locked up in third, would it confuse the display by showing the wrong gear? (P. B., via email).

● The Gear Indicator should indicate the correct gear irrespective of lockup in the torque converter. This is because the unit is calibrated when driving on a flat road at a steady speed and so the torque converter should have minimum slippage anyway. However, calibration in fourth gear may need to be done with the converter locked.

If the unit is calibrated in fourth gear when there is slight acceleration and hence slippage in the torque converter, it may be possible to calibrate this as gear 4, with gear 5 when the converter is locked. That's if that is what you want.

Alternatively, you may be able to calibrate for lock-up in gear 3 (call it gear 4), if gear 3 is calibrated with the converter slipping. Then you could use the gear 5 and 6 numbers for fourth gear and fourth gear with lock-up.

If we were doing it though, we would set it up just to indicate four gears and not worry about the lock-up condition.

Notes & Errata

PortaPAL PA Amplifier, February & March 2003: the main PC board (code 01103031) has an error which needs to be corrected. The link near pin 1 of IC5 connects on one side to ground but the other side is disconnected. It should go to the emitter of Q1 via the adjacent track. The end of the 18kΩ resistor adjacent to the open circuit link should be connected instead to the adjacent track which goes to pin 7 of IC5.

A revised PC board pattern has been placed on our website and forwarded to kit suppliers.

Solar Panel Regulator, March 2002: the PC board component overlay on page 85 shows diodes D1 & D2 mounted with metal sides down. They should be mounted metal side up, the same as the Mosfets.

Speed Controller For Universal Motors, October 2002: the PC board diagram on page 17 shows a 5404 fitted as D3. This should be a 6A diode such as R250H or PX6007. **SC**

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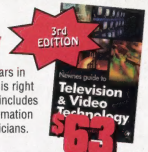

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New RF-232™ Protocol Enables Drop-in Installation of Industrial-temperature 2.4GHz FHSS Transceivers

Representing a breakthrough in industrial RF communication, AeroComm's unique transparent protocol simplifies the wireless integration process by allowing for true plug-and-play installation. This new 'RF-232' technology is embedded into compact AC4424 industrial-temperature 2.4GHz FHSS transceivers. RF-232 guarantees successful communication while making the process invisible to the OEM.

As each AC4424 transceiver receives raw data, RF-232 manages over-the-air protocol to gain acknowledgements, send retries, check errors, and other features unique to RF that newcomers to the discipline typically forget about. Headers, data packet length and CRCs are not needed.

The transceiver supports point-to-point, point–to-multi-point, and multipoint-to-multipoint configurations. Accordingly it is able to broadcast data to all transceivers, or it can 'address' packets to specific destinations using unique MAC addresses embedded into each radio. The use of 32 channels enables independent, co-located non-interfering networks.

Stop Press!
A new ultra low cost 900MHz Feature Rich, Spread Spectrum Module is being released soon!
Stay tuned to our website www.radiomodules.net for more information

Telelink Communications have a Low Power Radio Module solution for you!

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